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THE DIVERSITY FACTOR.

A lot of discussion is going on in our foreign contemporaries in regard to the value of the so-called diversity factor. The accepted definition of this factor is the ratio of the sum of the maximum demands of the consumers supplied by the plant to the maximum demand made at any time on the station. Obviously a definite numerical value can not be given to such a factor, for it will vary, depending upon the season of the year or the time in which the maximum demands are to be taken. In practice this factor would always be larger than unity; and the larger it be, the better it is thought will the load on the station be distributed throughout the day. This view results from the experience that the greater the number of consumers supplied by the plant, the more uniform its load.

The diversity factor, as thus determined, does not seem altogether satisfactory for the purpose for which it is intended, which is really to give some idea of the various uses to which the power of the station is put. It takes no account of the length of time during which various maximum demands are made, and a low load-factor might be accompanied by a high diversity factor, although the opposite relation is supposed to obtain. It would seem better, in obtaining a factor of this kind, to bring in the load-factors of the different consumers. For example, take the ratio of the sum of the load-factors of all consumers to the load-factor of the station. The resulting figure would bring in not only the maximum demands, both of the consumers and on the station, but a time-factor which would allow for the characters of all the loads.

IMPROVEMENTS IN WIRELESS TELEGRAPHY.

According to press accounts published during the past week, Professor F. Braun has succeeded in setting up electromagnetic waves which will travel in one direction only, and do not spread out in a circle like the sound from a bell. If this report be true wireless telegraphy will be benefited greatly, for such a method would not only decrease the amount of power required at the sending station—an item of consideration, although not of paramount importance—but, most important of all, would reduce largely interference of one station with another. As yet no description has been published of how Professor Braun accomplishes this, but his work heretofore in wireless telegraphy has been so successful that we may confidently expect that some important improvement has been made.

Of interest at this time is a study of wireless telegraphy made in the *Electrical Magazine* (London) for June, by Mr. L. H. Walter. The author considers the different elements of a wireless system, and comes to the conclusion that since, as Professor R. A. Fessenden has shown, a receiver may be designed which requires less than one one-hundredth of an erg to operate it, this part of the system has advanced to a satisfactory stage. The transmitter, however, is not so satisfactory. In the first place, as a transmitter its efficiency is somewhat low—ten per cent, he says; that is to say, only one-tenth of the energy supplied to the transmitting devices is converted into electric waves. When to this considerable loss that caused by the requirement that a large circular area of the medium be set into vibration in order to operate a delicate device at one point only is added, it will be realized that it is at the sending end of the system that efforts should be concentrated. An effort in this direction has been made by Professor Artom, who believes that he has succeeded in setting up a polarized electric wave which seems to set into vibration an elliptical section of the transmitting medium. His results have not, however, been verified as yet. Whether Professor Braun's new method produces results of the same character as Artom's, or whether he really sends out a beam of waves, is not clear. The probability is that the waves which are sent out spread through an ever-widening angle, and that the statement that they are sent out in one direction only must be accepted in a limited sense.

THE INDUCTION GENERATOR.

The new type of generator described by Mr. William Stanley in his paper presented at the recent convention of the American Institute of Electrical Engineers, an abstract of which will be found on another page of this issue, possesses some exceedingly interesting features. The machine itself—that is to say, the generator proper—is not altogether new, although the use of such an arrangement as is here described as a generator is novel. The rotation of a magnetic field relative to stationary conductors, produced by a combination of mechanical rotation and the action of polyphase currents, has been employed in so-called frequency changers—machines employed generally to raise a low frequency suitable for power purposes to a higher one more suited for electric lighting. In such machines, however, the frequency changer draws its energy from the electrical supply circuit; and hence must be considered more as a transformer than as a generator which converts mechanical into electrical energy.

Although the characteristic features of the induction alternator described by Mr. Stanley may be compared with those of the frequency changer, the machine itself differs in its proportions. In the first place the electrical energy supplied to the generator is small compared with the mechanical energy; and in the second place the difference in frequency of the currents flowing in the stator and rotor is much more than that customary in the frequency changer. In the machine as described, the rated output of the exciter was only from six to eight per cent of the rating of the generator, and the frequency of the exciting currents is much lower than that given by any ordinary types of alternators. The exciting currents have a frequency of not more than one or two cycles per second, and may be even as low as one-half cycle per second.

The peculiar feature of the induction alternator is the use of polyphase exciting currents in a rotating field; and the value of such an arrangement is that it enables the winding on the rotating field to be driven at a speed which is not synchronous with the rotating flux. These conductors therefore are cut by the flux, and hence have electromotive forces set up in them, which electromotive forces may be made to set up currents which either assist or oppose the field flux. It must be remembered that the flux which actually cuts the exciting conductors is a resultant of all the currents flowing in all the conductors of the generator. It is a combination of exciting flux and that set up by the armature reaction; it therefore varies with the load on the armature—that is to say, the alternator becomes automatically self-compounding. This action in this way may be compared with that of a direct-current generator in which the brushes are given a backward lead. As is well known, the machine may be made more or less self-regulating by merely shifting the brushes back of the neutral plane; but unfortunately the disastrous sparking which results prohibits the use of this simple arrangement. Other schemes have been proposed for obtaining a similar effect without ruining the commutation of the generator, but we believe that this is the first time such a reaction has been employed to make an alternating-current generator self-regulating, without at the same time adding a commutator to it.

Judging from the published results the machine appears to have excellent regulation, which it can not be denied is of much advantage. In discussing this machine some one said that good regulation was not of as much importance to-day as formerly on large systems, because on such systems great variations at a single point are lost when they reach the station. Nevertheless, variations in load must occur, and a generator which can be made perfectly regulating without going to too great expense will be the one selected for the small plant, and will surely have the preference for the larger installation.

The exciter devised by Mr. Stanley for supplying the induction generator is an unusually interesting machine. It operates on an entirely new principle. The problem was to devise a dynamo which, without being too bulky or running at too low a speed, would give the very low frequencies desired. The method by which this has been done is most ingenious. The exciter, instead of being, as has heretofore been invariably the case, a direct-current generator, is a self-exciting, polyphase alternator, having, however, an armature wound for direct currents. In its simplest form it may be described as a four-pole field. The exciting current for opposite pairs is drawn from brushes set at right angles to the position they would have in a direct-current dynamo—that is to say, it may be considered as made up of two two-pole fields placed at right angles, each field being supplied by the brushes belonging to the other. With this arrangement, assuming one pair of the poles to be magnetized somewhat when the armature is revolved, an electromotive force will be set up in its windings which will force a current through the windings of the other pair of poles. As these become magnetized the neutral plane shifts forward (or backward), and a current begins to flow from the other pair of brushes in a direction such as to reverse the magnetism of that pair of field-poles. While this is being done the neutral place is still shifting forward, so that the voltage of the second pair of brushes is becoming less and less. This field will thus tend to die out as the field in the first pair of poles is suppressed, reversed and raised to a negative maximum when the conditions at starting are exactly reversed. This process goes on cyclically at a speed determined by the electrical constants of the armature and field circuits. The exciter thus produces a field which slowly rotates. It therefore will give off from its brushes alternating currents of a frequency determined by this rotation. In other words, it is a polyphase, self-exciting generator, as it supplies from one armature the exciting currents required for its own fields and for those of the induction alternator. Obviously such a machine will be affected by the current flowing in its armature; and by proper design of alternator and exciter the characteristics of the two may be so selected as to produce almost perfect regulation.

An interesting line of thought was suggested during the discussion of these machines, how will they behave as motors? The generator will obviously run as a synchronous motor—that is to say, synchronous with respect to the relations of its rotation and the rotation of its field. If, however, the frequency of

the exciting current be varied, the speed of the motor will vary. In other words, it is a variable-speed, synchronous motor—which sounds like a paradox. Another question which may be asked is, how will the exciter behave as a motor? The field connections are of the shunt type, so that it would probably run as a constant-speed machine; but since, as is stated in the paper, one machine may be designed to give several frequencies, such a variable-frequency machine would probably become a variable-speed motor.

But little has yet been published with regard to these new machines to enable one to predict their performance as motors, but an interesting question arises whether such a system would be suitable for railway work. A variable-speed, alternating-current motor—that is to say, one whose speed can be varied without causing too great a loss of energy—is what has been sought by many for traction purposes. Given such a motor, the necessity for two or more overhead conductors would be viewed with more tolerance.

A POOR OUTLOOK FOR THE ALCHEMIST.

In the infancy of chemistry the alchemist was a much-abused individual. Some, perhaps much, of this abuse was deserved, but to-day he is given credit for having kept alive interest in the nature of matter. Money he had to have to carry on his research, and if a good deal of this was ill-gotten, the loser deserved punishment for dabbling with arts that at that time were supposed to be evil.

The alchemist of the future will hold an entirely different position in the world, at least so far as the opinions of others need be considered. He will not be shunned as he walks the streets, nor will those who wish advice in his specialty wait for the darkest hour of the night before seeking his den. Confidence and esteem he will have in plenty, but will he have control of fabulous wealth? We fear not.

These thoughts are due to some recent announcements in the field of physical science. Some time since we were told, on creditable authority, that transmutation of metals was not only possible, but a very probable fact. Radium, it was said, as a result of its radioactivity, was converted into another chemical element. Research in this interesting as well as important branch of physics has been active, and we are now told that it is probable—almost certain—that one of the products of this decomposition of radium is either lead or bismuth—probably lead.

Now, we are not wondering if the alchemist of the future is going to spend his spare moments in converting radium into lead, which would surely be an unprofitable undertaking—at least so long as the former element remains at its present market price. But if radium does change into lead—and if, as we are told, all the elements are living lives and are gradually being converted into elements of lower atomic weight—why might not lead be converted into gold? In the former transmutation the atomic weight of radium is 225, while that of lead is 206.9. For the latter transmutation the change need only be from 206.9 to 196.7 (the atomic weight of gold) and might be assumed to be correspondingly easy.

Assuming, for the sake of argument, that a way could be found of causing lead to change as actively as does radium—although the rate at which it changes at present is probably at least a million times slower—and assuming also, for the sake of argument, that the time required to bring about a transmutation is proportional to the change in the atomic weight, it is easy to figure out how long it would take to convert a pound of lead into a pound of gold. Professor Soddy says that it takes 40,000 years for radium to change into lead. It would therefore take over 22,000 years for the lead to change into gold; a rather slow process, calling for much patience on the part of the alchemist.

Now, look at the problem in another way. As gold is worth at the market price about 6,000 times as much as lead, it is easily seen that if any one owning a pound of lead should sell it for four and one-half cents, its present value, and invest this sum at compound interest at the rate of four per cent per annum, in approximately 221 years, three months and three days, the sum accumulated would be equal in value to a pound of gold. Evidently this method of converting lead into gold is more profitable than waiting for its transmutation, and the returns are quicker. In fact, during the time required for all of the lead to be converted into gold the sum accruing from investing the value of the lead at four per cent would be something like four, followed by 376 ciphers, dollars; more even than Scotty, of Death Valley, claims that his mine is worth.

Of course, it is not impossible that some means of hastening this transmutation may be discovered, but as yet nothing in this direction has been done, and even the most optimistic could hardly hope for an acceleration which would be considered a good investment to-day. And it is not improbable that any such process would require power worth more than its weight in gold—if one may use such an expression. Unfortunately, or fortunately—whichever way one wishes to look at it—the future for the alchemist presents a dismal outlook.

ELECTRIC LIGHT FOR PARKS.

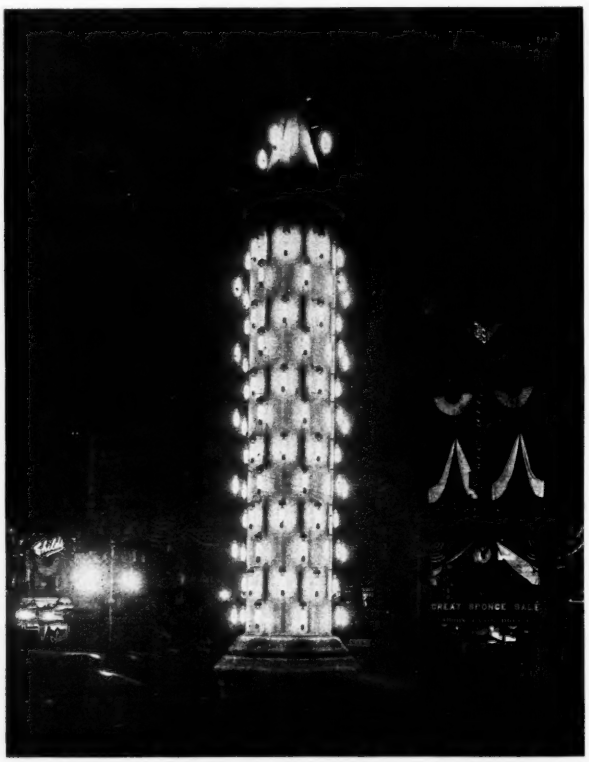
Probably the most striking feature of the decorations at Buffalo, in honor of the annual reunion of the Elks, was the large tower lighted by 100 Steinmetz mercury arc lamps. The tower was about seventy-five feet high, and was visible for miles around. It stood out boldly among the other illuminations, not only on account of its brilliancy, but because of the peculiar green color of the light emitted by its lamps.

One feature of this brilliant display which caused comment was the peculiar suitability of mercury arc lamps for park illumination. This feature of the lamp has been emphasized for some time past by Dr. Steinmetz, who has used the lamps for illuminating his grounds in Schenectady. The foliage of the trees loses nothing because of the absence of the red rays—indeed, its green color is brought out most beautifully by the green light. Many of those who commented upon the peculiar suitability of the mercury arc lamp for ground illumination thought that its use could be extended to street lighting as well, and that its green color would be but a slight objection. One point in its favor is its high efficiency. The rather large units in which it is put out, as compared with the incandescent lamp, will not be a great objection for outdoor illumination.

Electrical Features of the Elks Carnival at Buffalo, N. Y.

The entire business part of Buffalo, N. Y., was in gala attire in honor of the nineteenth reunion of Elks during the week of July 10. Bunting of many colors —purple, the Elks color, predominating— was draped everywhere in such profusion as even the glorious Fourth seldom witnesses. But if the daylight scene was gorgeous, it was far excelled by the electrical decorations which literally turned the night into day.

Through the energy and resourcefulness of General Manager Charles R. Huntley, of the Buffalo General Electric Company, the city streets presented a night scene of splendor probably never before equaled in similar celebrations. Niagara electric power had been freely drawn upon, and was everywhere in evidence through incandescent lamps festooned across the fronts of buildings in "Welcome" signs, and in elaborate special designs embodying the characteristic Elk emblems.



"Mercury Arc Tower," Shelton Square, Buffalo, N. Y., Elks Carnival, July 10–15.

The unique feature of this veritable festival of light was a "Mercury Arc Tower" located in Shelton Square. This was a fluted column of "staff" seventy-five feet high, studded with 100 mercury arc lamps. Standing alone in its splendor, this tower produced a startling effect, due largely to the characteristic greenish light of the mercury arc lamps. It stood out conspicuously in the mass of many-colored incandescents covering the fronts of the buildings on the square and the radiating streets. The natural curiosity of the people regarding its peculiar color caused a constant jam about its base. Inasmuch as the tower was visible for a long distance up the streets leading from the square, it received a great deal of attention and was freely spoken of as the most original feature of the carnival.

The mercury arc lamps were operated in two series of fifty lights each from four-ampere Brush arc machines located in the Wilkinson street station. As each lamp consumes only 160 watts, the operating expense was very low for so brilliant a spectacle. They are of the standard type for outdoor lighting as developed under the direction of Dr. Steinmetz, and manufactured by the General Electric Company.

This new use of the mercury arc lamp on a large scale marks a radical step in electric lighting for decorative purposes. The incandescent lamp reached its climax for general illumination and for decorative effects at the Pan-American Exposition four years ago in Buffalo, and it is interesting to note that the latest development in this branch of the art should be successfully tried in the same city and using also Niagara power.

This luminous tower was a special contribution to the carnival by the Niagara Power Company, the Cataract Power and Conduit Company, and the Buffalo General Electric Company. Mr. Huntley conceived the idea and designs were prepared by the illuminating engineers of the General Electric Company, and this company furnished the material and superintended the installation. The most elaborate decorative feature of the carnival utilizing incandescent lamps was located at the corner of Main and Seneca streets. This was a regular cobweb of wires studded with incandescent lamps of various candle-powers, the whole structure being crowned with four massive Elks facing the different quarters of the globe. It is stated that 4,000 lamps were used in this one feature. Many of the business houses of Buffalo employed experts to decorate the fronts of their buildings, and the results were decidedly pleasing. On account of the carnival many stores increased their window lighting or added new signs which will remain permanently. Thus, the celebration not only increased to a very large extent the temporary lighting of the local company, but has added not a little to its permanent load.

The Electrical Development Company, of Ontario.

The great undertaking of the Electrical Development Company, of Ontario, Limited, and the Toronto & Niagara Power Company is progressing with all possible speed, and the engineers in charge are sanguine of the very early use of the immense amount of energy which will be developed by these companies. The main features of the plans include the generation of 125,000 horse-power; a main tailrace tunnel of 1,935 feet; 550 feet of subsidiary tunnels; a wheel-pit 416 feet long and 144 feet deep; a power-house 500 feet in length; eleven generators, each of 12,500 horse-power; a private right of way of a minimum width of eighty feet, from Niagara to Toronto, for transmission of power; steel towers for the transmission lines instead of wooden poles; and a town site having a frontage of one and three-quarters miles on Welland river, three miles from Niagara, for the location of prospective industries.

Colonel H. M. Pellatt is president; Frederic Nicholls, first vice-president and general manager, and William McKenzie, second vice-president. These gentlemen, with the Hon. George A. Cox and James Ross, form the board of directors. The secretary is Mr. H. G. Nicholls, and the treasurer, Mr. D. H. McDougall. Mr. F. S. Pearson is the chief consulting engineer; Hugh L. Cooper, chief hydraulic engineer; W. T. Jennings, chief engineer of the right of way; Beverley R. Value, resident engineer in charge of the work, and Robert C. Brown, chief electrical engineer.

The Electrical Engineer in Heavy Traction Work.

A discussion has been given by Mr. William McClellan of the various methods adopted by electrical engineers for solving the problems connected with heavy railway work. The work undertaken may be either a substitution or a project problem. In either case there are three methods of attacking the problem: the first is called the observation method, which involves the use of a dynamometer car, and is useful for a substitution problem only. The second is the speed-time method, and may be applied with varying difficulty to either type of problem. The third is called the mean power method, and is the most approximate of the three mentioned. In the observation method a dynamometer car is employed, by means of which the power required to move various classes of trains at various speeds over a line is determined. From these readings the energy consumption of each train and the required output at the station are determined. These curves enable the equipment of the trains and power-house to be selected. The speed-time method, while applicable to either class of problem, is most particularly so to the project problem. Here the grades and alignment of the road are given, and the schedule and character of the trains have been determined upon. A set of motor characteristics is obtained, from which a speed-time curve for every different run called for on the schedule is plotted. From this speed-time curve current-time curves for each run may be plotted. This enables the equipment of the various trains to be decided upon; and by combining the curves for all the runs, the station equipment is also selected. The data thus obtained also enable the feeders and the various substations to be designed properly. The work is laborious, and many graphical methods have been devised for shortening it. The most suitable is that suggested by Mr. C. O. Mailloux, which is known as the "chart" method. In the use of any method it will often be found time-saving to plot a series of general curves and interpolate from these. To obtain these curves it is necessary to analyze train motion and get expressions for the various resistances that dissipate energy. These are grades; curves; brake; train resistance, consisting of mechanical friction and wind friction, each of which may be subdivided again; and inertia, due to translation and to rotating parts. These various resistances are discussed by Mr. McClellan, values for each being given. The mean power method is hardly more than a refined guess. It is useful in the very simplest projects only. Having a small amount of recorded data a guess is made of the amount of power required by a car to go over a certain average roadbed. On this scanty basis estimates may be made of the amount of power required by the road, and motors selected for the work. Mr. McClellan suggests the need for a small, well-equipped testing table to be introduced into every electric car and used for recording the various data desired.—*Engineer's Club (Philadelphia), July.*

An Epoch in the Turbine Art.

With the successful closing of recent negotiations for two 7,500-kilowatt Westinghouse turbine type generating units, the New York Edison Company has inaugurated an important epoch in the history of metropolitan electric lighting in this country by adopting generating units of such unprecedented size.

The importance of this step is enhanced by the fact that these turbine units will be installed in the finest and largest of American central stations, Waterside station No. 2, that ultimately will contain ten units of the same size. Waterside station No. 1, it will be remembered, is equipped with Westinghouse vertical three-cylinder compound reciprocating engines which, although installed only a few years ago as then representing the highest type of large engine construction, have so soon been outclassed through the rapid advance of the steam turbine system. No less than eleven of these large engine type units are now in service in this station, each rated at about 6,500-horse-power capacity and direct-connected to a 3,500-kilowatt generator. The next step in the acquisition of larger units resulted in the installation of 5,000-kilowatt turbine units of the Curtis type.

In the equipment of the new Waterside station with Westinghouse turbine units of still greater capacity, over twice that of the original engine-type units, there will here exist a striking example of the extremely rapid development in power-station construction that has taken place since 1900.

The compactness of the new generating unit is evidenced by the small space it requires in the new power-station arrangement. Its overall dimensions are approximately: length, fifty feet, width, seventeen feet; height, fifteen feet; floor space, 850 square feet per unit net, or 0.113 square foot per kilowatt capacity.

A condenser of the surface type will be located beneath the turbine in the foundations proper.

The new turbines will operate under 175 pounds steam pressure, approximately twenty-eight inches vacuum and 100 degrees superheat, the normal speed of the unit being 750 revolutions per minute. Under these conditions the economy of the complete unit will be in the neighborhood of sixteen pounds per kilowatt-hour at full-rated load.

Each unit will have an overload capacity of at least fifty per cent or will be capable of developing full-rated load without the use of a condenser. A distinctive feature of this design is that the turbine gives its best economy around full-rated load, although a large overload capacity is at all times instantly available when required without material sacrifice of efficiency. At this maximum load each turbine will be developing over 15,000 horsepower at the shaft, which is by far the greatest amount of power ever developed in a single prime-mover in stationary service.

The direct-connected turbo-generators will be of standard Westinghouse construction, delivering 6,600-volt, three-phase current to the high-tension network at a frequency of twenty-five cycles per second. The generators will embody the new enclosed construction which constitutes an important advantage in the entire elimination of the hum peculiar to high-speed turbine generators. They will have an efficiency approximating 97.5 per cent at full-rated load. Each generator will be able to sustain for several hours an overload of fifty per cent within reasonable temperature rise.

It is of interest in connection with this important installation that almost simultaneously three Westinghouse turbine units of the same size have been adopted by two large Brooklyn power stations, one for railway and the other for lighting service, making a total of over 50,000 horse-power in turbine machinery of this size. Two units will go to the Brooklyn Heights Railway Company and the third to the Brooklyn Edison Company.

The Electrification of the Michigan Central Railroad.

The construction of the Detroit Tunnel Line from Windsor, Ont., to West Detroit Yard, Michigan, including the electrification thereof, has been placed in charge of an advisory board of engineers consisting of William J. Wilgus, vice-president and chief engineer of the New York Central & Hudson River Railroad; Howard Carson, consulting engineer, and W. S. Kinnear, chief engineer of the Tunnel Company. The chief engineer will be in direct charge of construction, reporting to H. B. Ledyard, chairman of the board of directors, on executive and financial matters, and to the board of advisory engineers as to plans, specifications and methods of doing the work.

THE MERCURY VAPOR CONVERTER.[1]

BY P. H. THOMAS.

The motor-generator set or the rotary converter has, broadly speaking, long been the only practical commercial apparatus for the conversion of alternating current

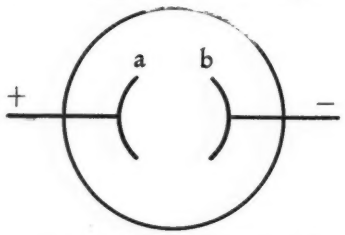


FIG. 1.—VACUUM TUBE, FILLED WITH MERCURY VAPOR, AND PROVIDED WITH TWO ELECTRODES.

to direct current. In large units, and when operating from polyphase circuits, this is a very satisfactory equipment, but the small single-phase motor-generator set is altogether an unsatisfactory piece of apparatus. It is largely used to charge

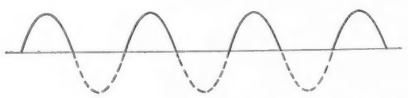


FIG. 2.—INTERMITTENT CURVE, HALF OF EACH CYCLE DROPPED.

small storage batteries and often has to be placed in private automobile houses where the attendant is not competent.

As a substitute for such apparatus the mercury vapor converter finds a great field, for not only is it more efficient than

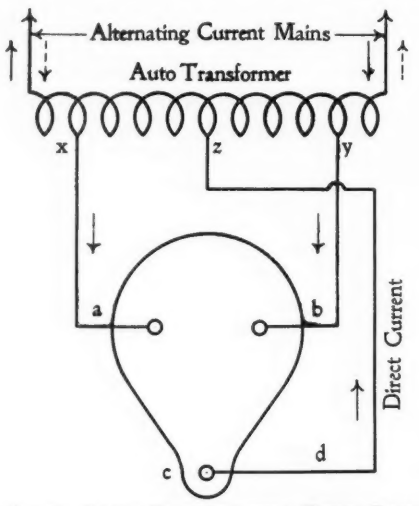


FIG. 3.—GLOBE PROVIDED WITH THREE ELECTRODES AND CONNECTED TO AN AUTO-TRANSFORMER.

a motor-generator set of similar size but it has practically no moving parts, and may be made to start with the simple closing of the main switches so that it is self-starting in case the power goes off.

[1] An experimental lecture before The Electric Club, April 28, 1905. The *Electric Journal*, July, 1905.

The development of the vapor converter has been most rapid and though it undoubtedly will have many improvements in form, it is a commercial success, being on the market in various sizes up to thirty amperes.

The operation is as follows:

Let Fig. 1 represent a vacuum tube or globe filled with mercury vapor and pro-

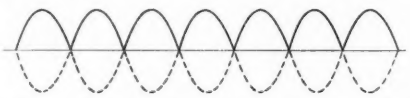


FIG. 4.—BOTH ALTERNATIONS ACTING IN THE SAME DIRECTION.

vided with two electrodes. In order to establish a current across this gap, it is necessary to raise the potential to a very high value, perhaps 25,000 volts, but after the current is once established ten to fourteen volts is sufficient to maintain it. This high starting potential is practically all due to a peculiar resistance offered between the mercury vapor and the surface of the negative electrode. As soon as the current is established this particular potential drops to about four volts. The total running potential is made up about as follows: four volts between the positive electrode and the mercury vapor, two to six volts through the mercury vapor and four volts between the mercury vapor and the negative electrode. If we have a long thin tube like a lamp, the potential through the vapor is much higher and may be as high as seventy volts. The potential at the positive electrode and that through the mercury vapor are approximately the same for both starting and running.

If once the current flow ceases even for an instant the negative electrode resistance is established and the high starting potential must again be applied. It is one of the remarkable characteristics of this apparatus that, though the period of zero current is but momentary, it is quite sufficient for the high resistance of the negative electrode to establish itself. It

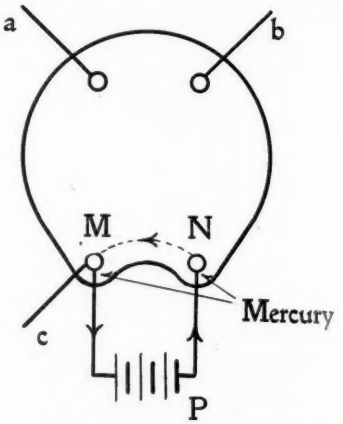


FIG. 5.—METHOD OF CONTINUOUSLY BREAKING DOWN THE HIGH RESISTANCE AT C.

has been estimated that this can occur in one-millionth part of a second.

Thus if the apparatus is supplied with

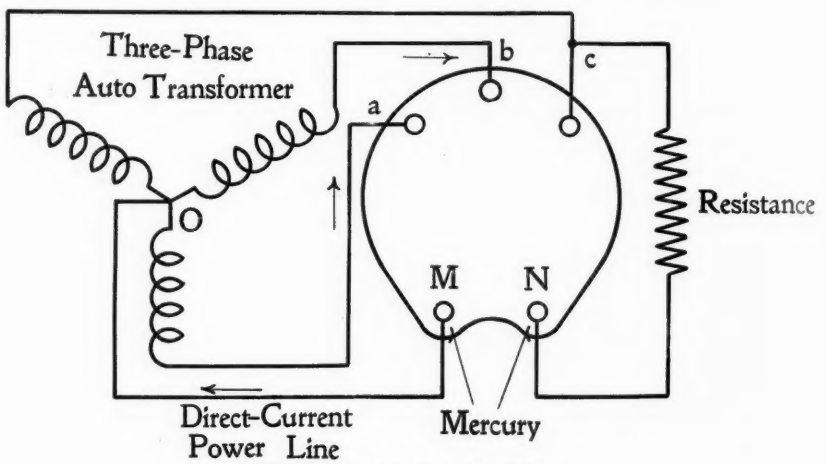


FIG. 6.—POLYPHASE CONNECTIONS.

direct current it will operate continuously on a low voltage after it is once started. If, however, it is supplied with alternating current, the high starting voltage

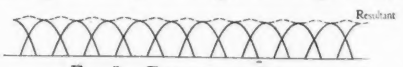


FIG. 7.—RESULTANT CURVES.

will have to be applied at each alternation and obviously at alternate electrodes, since they will change their signs with each alternation.

If now some means of breaking down this high potential is permanently ap-

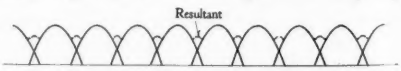


FIG. 8.—RESULTANT CURVES.

plied to one electrode, as *b*, Fig. 1, and alternating current is applied, it is evident that the current will flow through the apparatus only in one direction, from

a to *b*, since there will be now no electrode resistance at *b*, whether *b* is positive or negative, but there will be resistance at *a* every time *a* is negative. This resultant current will be intermittent, half of each cycle being dropped as indicated in Fig. 2.

If the globe be provided with three electrodes connected to an autotransformer as shown in Fig. 3, both alternations may be made to act in the wire *d* in the same direction. The direct current produced in this wire is still a pulsating one, but the zero period is reduced to a single instant as shown in Fig. 4.

In Fig. 3 the electrode *c* is provided with the means mentioned above (to be described later) for breaking down the high negative electrode resistance at all times. The operation is as follows: for one-half cycle, the current flows from *x* to *a* through the mercury vapor *c*, to *z* and back to *x* and *y*. During the second half cycle the flow is from *y* to *b* through the mercury vapor to *c*, to *z* and back to *y* and *x*. A circuit can not be established between *a* and *b* in either direction since one or the other is always negative and therefore it would require the 25,000 volts to start a current either way through this path. The line *c z* contains the direct-current apparatus to which the converter is to supply power and will carry a pulsating current as indicated in Fig. 4.

Fig. 5 represents one method of continuously breaking down the high resistance at *c*. The small battery P is so placed as to send its current as indicated in the figure. When current flows from the battery the electrode *c* will remain open to all currents from *a* and *b*, while *a* and *b* are always open to ingoing currents and always closed to outgoing currents. The initial starting of the battery current is easily accomplished by tilting the globe backward and forward, allowing the liquid mercury to flow over the ridge between M and N thus making a momentary metallic circuit. As soon as this mercury bridge is broken, the current is transferred to the vapor without there being an opportunity for the negative electrode resistance to be established.

If polyphase current is used with a similar apparatus, the battery is unnecessary since at no instant will all the legs of the polyphase circuit be zero; thus the flow of current never ceases. The connections are shown in Fig. 6. As before, operation is started by applying either alternating current or direct current between M and N and rocking the globe causing the liquid mercury to flow between these points breaking down the high potential at M. For example, suppose that at the instant the resistance M is broken down, the potential at *a* is just rising from zero, current will flow from *a* to M; 120 degrees later current starts from *b* to M; 120 degrees after this current starts from *c* to M. In the meantime the current in *a* has gone through the cycle. Before the current in *c* reaches zero, the current in *a* has started on its second cycle, and so on, so that at any instant there is current passing into M and the resultant current in the power line M *o* is as shown dotted in Fig. 7.

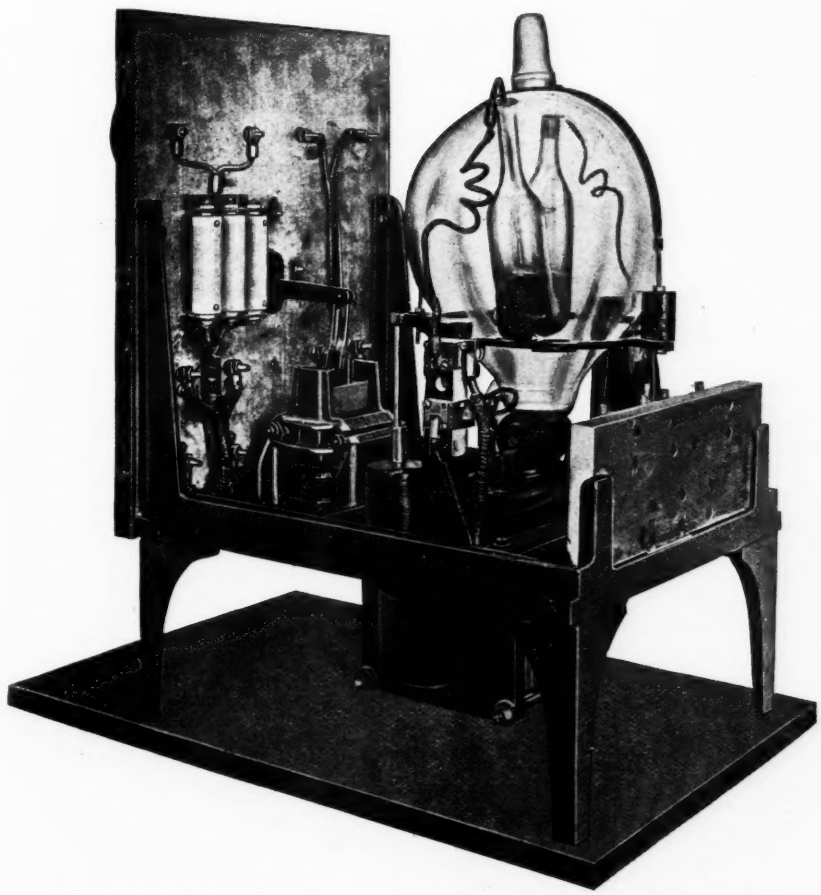


FIG. 9.—SINGLE-PHASE, SELF-STARTING VAPOR CONVERTER FOR CHARGING STORAGE BATTERIES—REAR VIEW.

This practically solves the problem of a continuously operating converter for polyphase currents, but the many private automobile stables in the resident districts, which are reached only by single-phase alternating current, as well as many other considerations, create a demand for a single-phase self-starting converter. Such a converter has been constructed, and, as previously stated, is actually in commercial use in sizes up to thirty amperes. To understand the principle of operation refer to Figs. 3 and 4, where it will be noted that the period of zero current is of an instant's duration, but that at each zero point the 25,000 volts must be applied. If, however, these current waves could be made to overlap even a very slight amount, as shown in Fig. 8, the converter would operate continuously. This is accomplished by inserting a reactance coil in the line *c z*, Fig. 3, which causes a slight lagging in the currents and makes them to overlap as shown in Fig. 8. For example, the current from *a* does not become zero until the current has been established in *c* by the rising voltage in *b*. The resultant current in line wire *d* is shown by dotted lines in Fig. 8. This is, of course, a fluctuating current, but with sufficient reactance in the circuit *d* and possibly some reactance or resistance in the main line to give backing, the converter will operate continuously without going out.

The commercial form of the apparatus is shown in Figs. 9 and 10. By means of small electromagnetic devices, the converter is made self-starting with the throwing in of the main switches. The bulb is made

of glass and mounted on suitable knife-edge trunnions so that on starting it may be easily tilted, causing the liquid mercury to flow between the two liquid electrodes located in the bottom of the bulb. As soon as the operation is established, the tilting mechanism is automatically switched out. The choke coil or sustaining coil is seen below the frame; the variable choke coil used as a regulator may be seen behind the panel with its operating handle passing through the panel. This coil is connected directly in the supply mains.

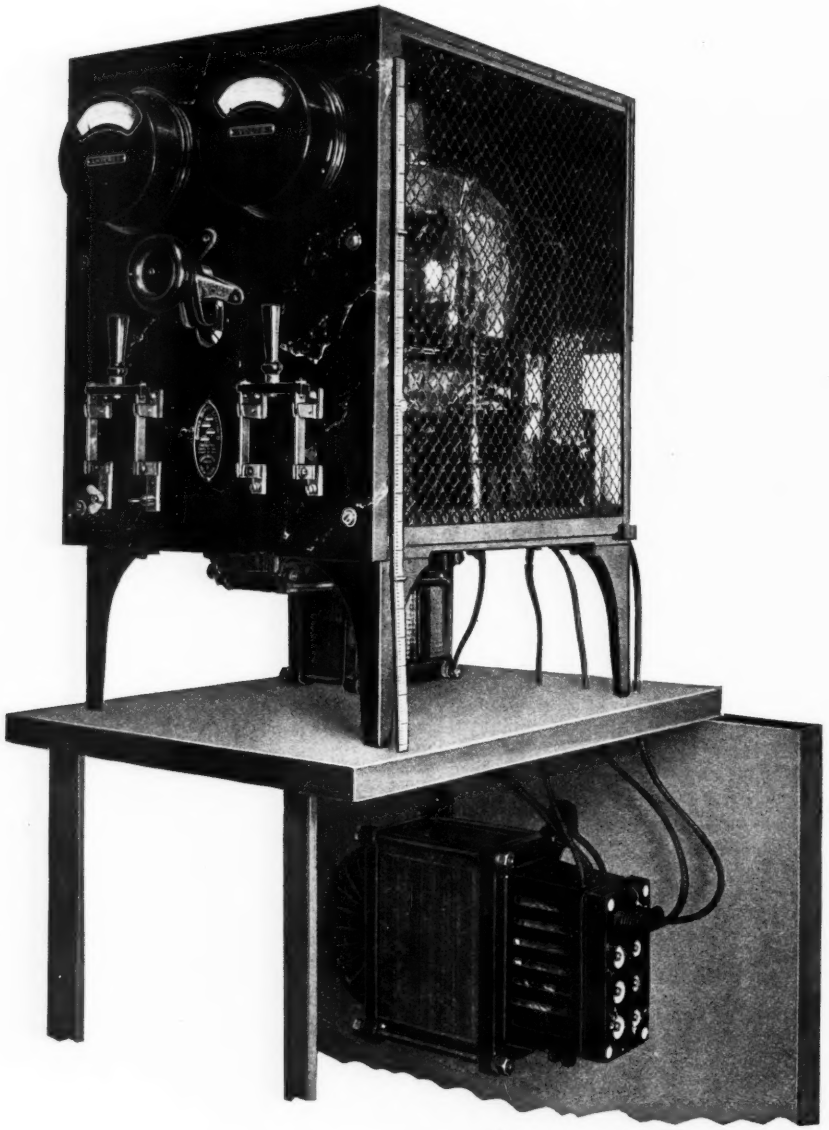


FIG. 10.—SINGLE-PHASE, SELF-STARTING VAPOR CONVERTER FOR CHARGING STORAGE BATTERIES—FRONT VIEW. TWO-FOOT RULE GIVES AN IDEA OF RELATIVE SIZES.

The apparatus is in no sense a transformer. It does not convert energy from one form to another. Its action is simply that of a set of valves opening and closing gateways and thus allowing currents of one direction to flow through a given line.

About fifteen volts are lost in the vacuum for all currents. The losses in the auxiliary apparatus, choke coil, transformer, etc., may be calculated as those in any design of similar apparatus.

The influence of the character of the load upon the design and operation of the sustaining coil (that is the choke coil which keeps the converter alive) is quite marked. When supplying current on a resistance load it is evident that whatever the drop in the supply voltage, provided the remainder is greater than the fifteen volts which are lost in the converter, a certain amount of current will flow through the resistance and the sustaining coil has to keep the converter alive only during those periods when the alternating current is below fifteen volts. With a battery load, however, the supply can pass current only during those periods when the supply voltage is greater than the battery voltage plus fifteen volts, and in case we wish an efficient arrangement the battery voltage must be as near the alternating-current voltage as possible; consequently the sustaining coil has to keep the converter alive during a considerable portion of the cycle.

In case of drop in the supply voltage when the converter is operating upon a resistance load the result is merely to reduce the current. When operating upon a battery load since the counter-electromotive force of the battery is constant a drop in supply voltage may much more easily cause the converter to go out.

The type BA converter outfit which is the standard apparatus for charging automobile storage batteries is so adjusted as to stand all ordinary variations of voltage without going out. In case of extraordinary drops of voltage the apparatus, being automatic, starts itself again after the return of the supply. This apparatus allows a very close adjustment of current and is generally well adapted to the conditions of commercial service.

Further applications of the vapor converters to other work, both larger in capacity and different in character from battery charging outfits, may be looked forward to in the near future.

The ultimate limits of the place in the electrical field to be taken by this apparatus will not be determined for some time to come.

The Light of the Firefly.

Sir James Dewar, in a recent lecture on "Flame" before the Royal Institution in London, presented some figures showing the energy expended in the production of light. It is interesting to note the high efficiency which is attributed to the Cuban firefly. The figures given are as follows:

	Percentage of Light.	Non-Luminous Energy.
Candle	2	98
Oil	2	98
Coal gas	2	98
Incandescent lamp	3	97
Arc lamp	10	90
Magnesium lamp	15	85
Cuban firefly	99	1

NOTES ON HEAT INSULATION, PARTICULARLY WITH REGARD TO MATERIALS USED IN FURNACE CONSTRUCTION.[1]

BY R. S. HUTTON AND J. R. BEARD.

INTRODUCTION.

The importance of a knowledge of the heat conductivity of the materials used for the bricks or linings of furnaces scarcely needs to be emphasized. There is no doubt that a careful study of this subject would enable a very large saving to be effected in the fuel or other heating costs in many experimental and industrial furnaces.

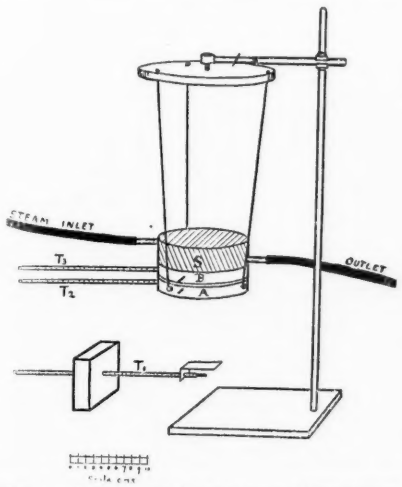


FIG. 1.—SKETCH OF LABORATORY APPARATUS.

A=round disc of brass on which the substance under investigation is placed; it is suspended from a horizontal support by three strings. The disc is 11.4 centimetres diameter and 1.3 centimetres thick. The powders are kept in position by a thin ring of red fibre, which in the present work was about 0.36 centimetre high.

B=upper disc of brass of same dimensions as A. It is surmounted by the steam box S, which is covered with felt to diminish the loss of heat.

A and B are provided with projecting pegs, the distance apart of which gives a measure of the thickness of insulating material.

T_1 is a thermometer registering the temperature of the air; it is provided with a screen to protect it from radiated heat from the lower disc.

T_2 and T_3 indicate the temperature of the lower and upper disc respectively, they are inserted into radial holes drilled in the brass.

The manufacturer and purchaser of refractory products both seem to ignore the necessity for accurately determining the quality of their material so far as its heat insulating power is concerned. Their specifications are confined to other properties, but it is doubtful if any of them are of greater economic importance than the heat conductivity.

So far as laboratory crucible and muffle furnaces are concerned, H. H. Cunynghame[2] has recently shown how greatly the efficiency can be improved by the adoption of better insulation.

Despite this lack of knowledge the measurement of thermal conductivities of such materials is by no means difficult to carry out, at any rate to within an accuracy of two or three per cent. C. H. Lees and J. D. Chorlton[1] have specially designed a simple apparatus for measuring the thermal insulation of bad conductors. We are much indebted to Dr. Lees, who very kindly lent the apparatus and also gave much valuable advice in carrying out the experiments.

MEASUREMENT OF THERMAL CONDUCTIVITIES OF GRANULAR MATERIALS UP TO 100 DEGREES CENTIGRADE.

All the substances dealt with have been either in the state of well-defined granular powders, or in some few cases where bricks have been examined, these were previously broken up and finely powdered. The apparatus of Lees and Chorlton was originally designed for round tiles or plates of material, but these have to be of uniform thickness and 11.4 centimetres diameter, and the shaping of bricks is not easily accomplished in the laboratory. A sketch of the apparatus is given in Fig. 1. It consists essentially of two thick metal discs between which the material is placed whose thermal conductivity has to be measured. The upper disc is surmounted with a steam jacket, while the lower one is allowed to cool by free conduction and radiation. Three thermometers are used, one to give the temperature of the upper, the second that of the lower disc; while a third gives the temperature of the surrounding air. The thermometers are inserted into radial holes drilled in the discs and thus denote their temperature with fair accuracy. When steam is passed through the steam jacket the temperature of the upper disc is raised to nearly 100 degrees centigrade, heat flows through the material experimented on and thus raises the temperature of the lower disc above that of the surrounding air. The lower disc loses heat by conduction and radiation to the air. Eventually a steady state is reached, when this loss of heat is equal to the heat received through the material experimented on.

The following equation enables the thermal conductivity (K) to be calculated from the result of such an experiment provided h_1, the external conductivity or "emissivity," has been previously determined.

$$K = \frac{t_2 - t_1}{t_3 - t_2} \cdot b \left(h_1 + h_1' + \frac{p}{2} \frac{h_1}{q} \cdot b \right)$$

Where t_1, t_2, and t_3 are the temperatures indicated by the thermometers T_1, T_2 and T_3 respectively, and b denotes the thickness of the layer of powder.

The value of h_1 is determined in a separate experiment from the rate of cooling of the lower disc at different temperatures.

In all the experiments here recorded the thickness was practically the same (0.360 centimetre), and as in nearly all cases the thermal conductivities were much of the same order, the term in the bracket was very nearly constant and equal to 0.00046.

Substance.[1]	Thickness in Centimetre.	Temperatures. Degrees Centigrade.			Conductivity.
		t_3	t_2	t_1	K.
Sand—white Calais	.360	98.4	81.0	18.2	.00060
Carborundum (fine)	.363	98.7	78.8	18.3	.00050
" (coarse)	.358	98.7	79.6	18.7	.00051
Quartz "enamel"	.362	99.3	75.4	21.7	.00036
" (fused)	.362	98.9	74.9	17.4	.00039
Firebrick	.363	98.7	69.2	20.3	.00028
Retort graphite	.363	100.0	76.6	19.6	.00040
Lime	.363	98.1	70.1	20.8	.00029
Magnesia (fused)	.356	98.7	78.6	20.0	.00047
" "Mabor" brick	.360	99.7	80.0	18.8	.00050
" calcined Greek	.365	99.3	78.3	20.4	.00045
" calcined "Veitsch"	.366	99.7	73.9	20.0	.00084
" Pattinson's light calcined	.363	98.0	58.5	19.7	.00016
Kieselguhr (infusorial earth)	.366	97.9	53.9	17.7	.00013

[1] Most of these granular powders just passed through a sieve with 600 meshes per square centimetre.

RELATIVE VALUE OF DIFFERENT HEAT INSULATING MATERIALS AT HIGH TEMPERATURES.

It is not advisable to choose a material suitable for furnace uses from the above data alone.

First, it is always necessary to know the general effect upon the substance under investigation of such temperatures as are likely to be experienced. Several, even among those materials mentioned in the table, are unsuitable for subjecting to high temperature on account of the physical changes, such as shrinkage, which they undergo. Chemical action, especially oxidation, also renders many insulators unsuitable for a large number of purposes.

Secondly, having by such considerations excluded all unsuitable materials from the choice, it becomes necessary to

[1] Paper read before the Faraday Society on Monday, July 3, 1905.

[2] *Journal Society of Arts*, vol. lii, p. 72, December 11, 1903 also *Engineering*, London, December 11, 1903.

[1] *Phil. Mag.*, June, 1896 (5), vol. xli, pp. 495-503.

compare the relative efficiency of those which remain under conditions more nearly approaching those experienced in practice.

The following experiments were carried out with a view to testing in as simple a manner as possible the behavior of various refractory materials at comparatively high temperatures.

The method employed, although it does not directly lend itself to the accurate measurement of the absolute conductivities, at any rate offers a practical means for making comparative tests.

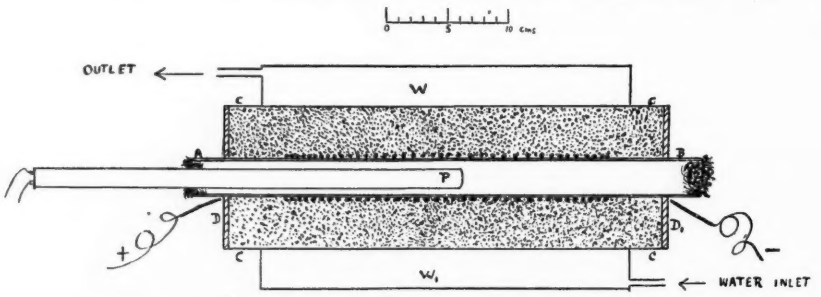


FIG. 2.—APPARATUS USED FOR COMPARISON OF HEAT INSULATORS AT HIGH TEMPERATURES.

A, B, unglazed porcelain tube with heating coil of nickel wire wound on its central portion.
The porcelain tube is kept in position at the centre of the cylinder of sheet iron C, C, C, C, by washers of asbestos card, D, D_1.
W, W_1 is the water jacket surrounding the cylinder C.
P is a thermoelectric pyrometer by which the temperature is indicated.
The granular insulating material under test fills the space between the porcelain tube and sheet-iron cylinder.

DESCRIPTION OF APPARATUS.

A modified form of electrically heated tube furnace was employed. An unglazed procelain tube, with a heating coil of nickel wire, is supported at the centre of a cylindrical, water-cooled enclosure, the space between the heating coil and the inner wall of the enclosure being filled with the granular material under investigation. (See Fig. 2.) The electric energy expended in the wire is kept constant over a considerable period by careful adjustment of an external resistance and constant observation of a precision wattmeter. The temperature at the centre of the porcelain tube is noted at regular intervals, and from the observations a curve is plotted to show the relation between the rise of temperature and the time during which the heating has been in progress. The temperature of the water flowing through the external jacket was kept fairly constant; generally it varied some two degrees centigrade.

In such an experiment it would require a very long time for the temperature to attain a constant value. It was, therefore, found preferable, after the rate of increase in temperature had become rather slow, to reduce the power by a small but definite amount. Under these conditions the temperature falls, at first very rapidly, but soon reaches a constant value, or, at any rate, falls so slowly as to be almost negligible. It is from a comparison of the heating curves with different materials and the same expenditure of power and particularly from the nearly horizontal portion of the curves with lower power expenditure, that valuable conclusions can be drawn.

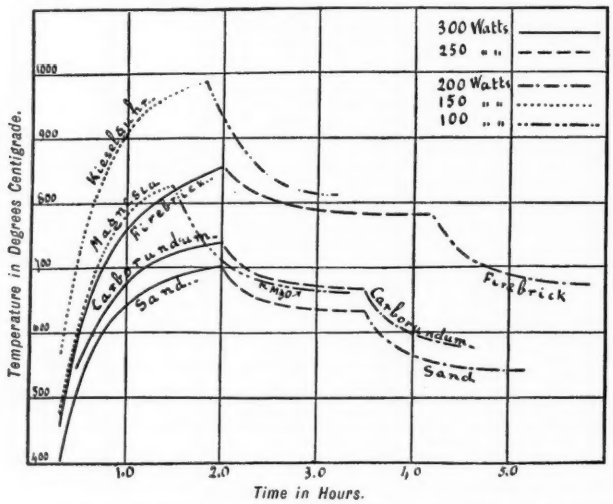


FIG. 3.—RESULTS OBTAINED WITH VARIOUS HEAT INSULATING MATERIALS.

The accompanying diagram (Fig. 3) illustrates some of the results obtained.

In the case of firebrick, carborundum, and sand, the preliminary heating was effected with 300 watts, and after the lapse of about two hours the power was reduced to 250 watts, being kept constant at this for a period of one and a half to two hours, by which time the temperature had become almost constant. The curves for kieselguhr (infusorial earth)[1] and light magnesia clearly show the very much smaller conductivity of these materials.

With these two substances the preliminary heating was effected with an expenditure of only 150 watts, but despite this the rise in temperature is more rapid than with any of the other materials mentioned.

Unfortunately, neither light magnesia nor infusorial earth can withstand any high temperatures for long without losing their efficiency to a considerable extent. Both substances exhibit large shrinkage at high temperature, and their chief uses are likely to be limited to external jacketing of furnaces lined with some more permanent but less good insulator.

To test more thoroughly the above method of comparing the relative efficiency of different materials at high temperatures, it was thought advisable to see what influence the preliminary heating might have on the results.

Two similar experiments were therefore carried out with the various substances. In the first case the preliminary stage of the heating was effected with 300 watts, in the second with 250 watts. In both cases the power was subsequently reduced to 200 watts and then to 150. The results showed that in all those cases in which no permanent alteration is brought about in the materials under test, the horizontal portions of the curve are practically identical, whatever the preliminary treatment had been.

In earlier experiments, in which no water cooling had been used to maintain constant the temperature of the outer jacket of the enclosure, some anomalous results were obtained.

GENERAL CONCLUSIONS.

The above results will, it is hoped, prove of value to those who have to deal with refractory materials. The subject seems to have been much neglected, considering that the thermal conductivity of such substances is the characteristic property which is really applied in their many uses.

While bricks and generally jacketing materials for furnaces should be of low thermal conductivity, it is of no less importance to choose crucibles, retorts, and other containing-vessels which are heated externally of as high conductivity as is feasible in conjunction with their other necessary qualities. Such methods as have been described are equally applicable to this latter case.

By a judicious use of the different materials and a stratified form of construction, it should be possible usefully to employ such excellent insulators as infusorial earth without risk of the damage which is inevitable if they be permanently subjected to too high a temperature.

The above experiments were carried out in the physical laboratories of the Manchester University.

[1] *Cf.* F. A. J. FitzGerald, *Electrochemical Industry*, 1905, vol. iii, p. 55.

The Development of the Ontario Power Company.[1]

By P. N. Nunn.

(Concluded.)

GRATIFYING accessibility has been obtained by compact arrangement of generators and turbines with ample clearances and good light upon the main floor of the station and in full sight not only of the immediate attendant but also of the chief operator from his post upon the gallery above. As explained, the entire gate-rigging is external, therefore accessible for lubrication, adjustment, or repair. Excepting runners and gates, every moving part is in plain sight and, by the ready removal of a single ring, even the guides themselves are exposed for cleaning or replacing. This arrangement, in strong contrast with that of the vertical type with its several floors, intervening stairs, and dark corners, will, it is believed, appeal to every power-house operator.

In the general arrangement of the works, symmetry and centralization of control are predominant characteristics. The generating and distributing stations are parallel and nearly 600 feet apart with 260 feet difference in elevation. On account of limited space the generating station is but seventy-six feet wide, though when completed it will be nearly 1,000 feet long. Down the centre of this building, side by side in a single row, stand the generating units with turbines next their source of supply. The space between them and the rear wall is occupied by a gallery upon which stands the row of oil-pressure governors, each almost over the end bearing of its turbine.

The distributing station, wider and shorter than the power-house, is divided into three longitudinal bays or five main sections. The narrow front bay contains the switches, bus-bars, etc., at generator pressure; the wider rear bay contains those at transmission pressure. Between these stretches the main middle bay divided transversely by a three-floor switchboard section into two long transformer rooms. The projecting central section provides space for operating offices. Along the centre of these two rooms the transformers stand in groups of three corresponding in position and capacity to their respective generators. Thus similar apparatus is arranged in rows parallel one with another and with the generating units.

At the generating station three inclined cable tunnels, one already built, carrying clay ducts, begin at the rear walls beneath the gallery and extend up through the cliff and, as standard subway, on to the distributing station. The main cables, except as diverted by these tunnels, follow the shortest and most direct routes from generators to transformers. They do not converge for the accommodation of switchboard at one or more centres where congestion, which in many installations causes the most disastrous accidents, prevents separation or adequate insulation. On the contrary, they are laid quite regardless of switchboard, the switches and instrument transformers of which are then placed as required by the cables.

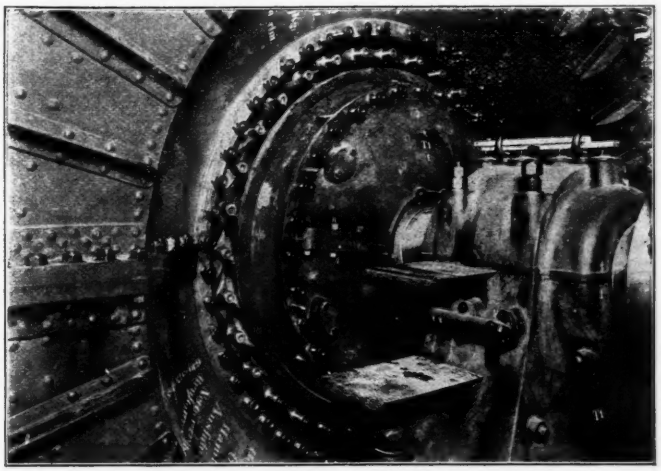


FIG. 5.—SWITCH-GATES, EXPOSED BY REMOVAL OF COVER PLATE.

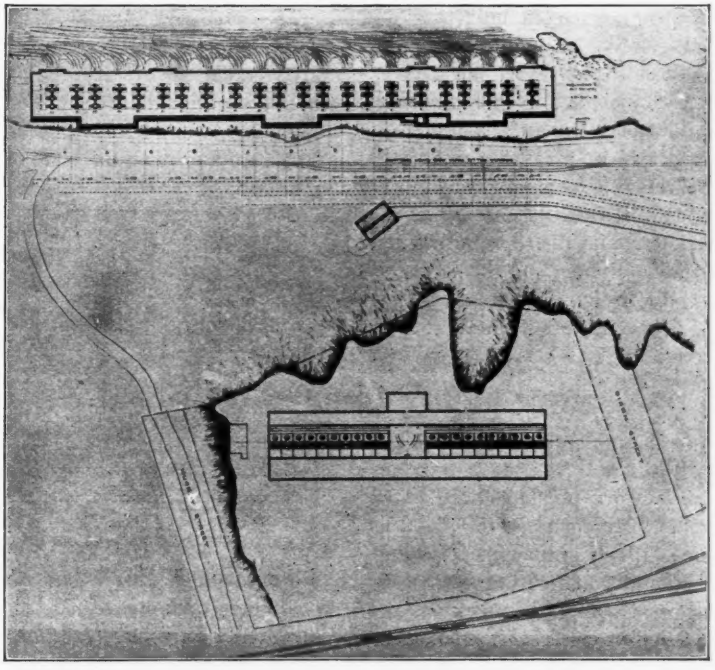


FIG. 6.—GENERAL PLAN OF GENERATING AND DISTRIBUTING STATIONS.

Unit values, corresponding to the generators in capacity and position, are maintained throughout. Thus each generating unit has its individual cables, switches, and switchboard, section of bus-bars,

[1] A paper presented at the twenty-second annual convention of the American Institute of Electrical Engineers, Asheville, N. C., June 19-23, 1905.

transformers, interrupters, and high-pressure switches complete to the transmission, enabling its independent operation as an isolated power plant or, through the selector switches and duplicate sectional bus-bars, the operation of

tunnel entrance are the main generator switches, and on one side the duplicate turbine-driven exciters and their governors, and on the other the motor-actuated main field rheostats. In front of the switches are a few panels of switchboard

At the distributing station the low-pressure bay contains upon the main floor the 12,000-volt automatic oil circuit-breaker in double column and, in the chamber beneath, on the sectional duplicate bus-bars and their immediate connec-

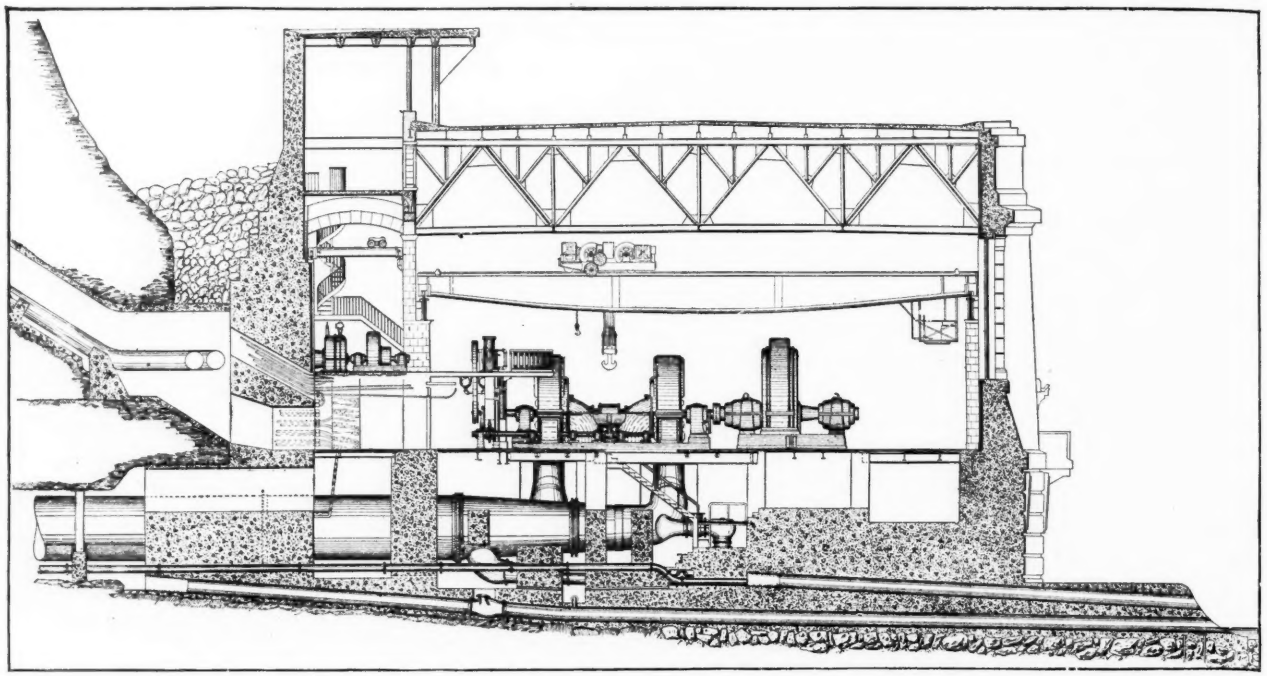


FIG. 7.—SECTION THROUGH GENERATING STATION, ONTARIO POWER COMPANY.

all units in any combination of groups as readily and perfectly as their operation in parallel. To this end a unit length of distributing station of similar relative position is devoted to the circuit and apparatus corresponding to each generator.

From the above it may be seen that the arrangement is in parallel courses; that like apparatus is arranged in rows or courses parallel with the long axis of the generating and distributing stations; that the main circuits and the unlike apparatus performing the successive functions of these circuits form twenty-two courses transverse to the same, and that the courses of the two directions form, as it were, a rectangular or checker-board figure covering an area nearly 1,000 feet square. The arrangement of these courses in logical sequence provides the short and direct route for the main cables previously mentioned. Such symmetry of arrangement, while difficult to attain in a crowded plant or at points of congestion, is of marked value in emergency, especially in a plant of many units, and becomes vital when the units are of such dimensions that the accidental crippling of one costs the output of many smaller plants.

Where the cable tunnels commence, the power-house and gallery are widened toward the cliff. Immediately above the

carrying exciter rheostats and switches, controls for actuating penstock valves, and the necessary circuits and apparatus for a limited local distribution. Relief-valves and small drainage pumps are the only operating machinery beneath the main floor, while upon it, in addition to the generating units, there are only dupli-

tions. In the transformer rooms the transformers stand in pits six feet below the main floor level, and parallel with them adjacent to the high-pressure bay are corresponding pits for static interrupters or other protective apparatus. Beneath both and between their foundations are accommodated the several systems of water, oil

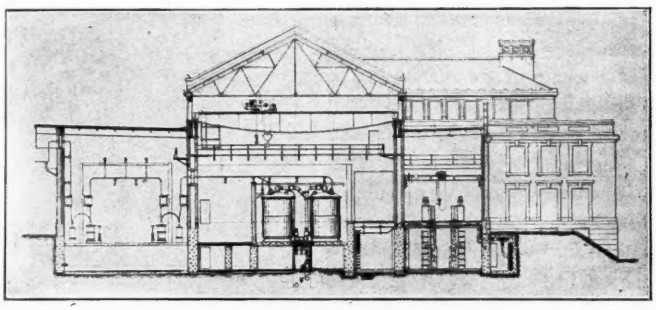


FIG. 8.—SECTION THROUGH TRANSFORMER ROOM, ONTARIO POWER COMPANY.

cate electrically driven pumps supplying the storage tank and transformer cooling coils at the distributing station. For air circulation and ventilation and to avoid dampness from spray as well as to ensure cool generators in hot weather, a cold-air supply to each generator is provided from a sub-floor chamber communicating with external shafts and heated air escapes through large roof ventilators.

and drain piping, and the main cableways to the transformers above. Each transformer is fitted with a record-making thermometer giving the continuous history of its internal economy.

The switchboard section occupying the centre of the distributing station has four floors of which the basement serves as a centre for the piping systems and gives room for conduits and cableways for

wiring. On the main floor and the mezzanine or gallery floor, marble slabs carry record-making and integrating instruments, terminal boards with fuses for the control cables, and other adjuncts of the switchboard above. Upon the upper floor is the switchboard and control chamber, and here instrument stands and control pedestals supplant both the conventional marble slabs and the later benchboard. Each of the twenty-two instrument stands, which are arranged approximately in a semi-circle about a central point, corresponds to a definite unit, carries nine indicating instruments, and faces its twelve-point control pedestal. Doors upon the four sides lead to balconies in the four other divisions of the building of which this room is the centre; those at the sides to balconies extending the full length of the transformer rooms.

Centralization of responsibility and authority, at defined points within the immediate personal care of a minimum number of chief operators, is, next to simplicity of arrangement, the prime requisite of efficiency of organization and of economy of operation. It is frequently possible so to arrange small plants of a few units as to centralize at a single operator, but with a plant of this scope that result is manifestly impossible. Two alternatives are then open; the division of the plant into several parts, each about its sub-centre constituting virtually a complete plant in itself and the whole dependent upon successful cooperation for unity of result or classification and centralization of responsibility according to kind. In this case the latter has been adopted, and notwithstanding that the number of units and aggregate of power involved have opposed high merit in this respect, a promising result has been obtained.

The concentration within a single room of all instruments and control—the brain of electrical operation—provides the operator in a quiet and secluded place both full information and perfect control of every electrical circuit and situation of the system, and enables him to stop, start, regulate, or synchronize each unit; to throw its output through its transformers to its transmission as if from a complete isolated plant or to throw it upon either bus-bar while supplying its transformers from the same or the other bus-bar. The location of this room high up at the geometrical centre of the distributing station places the operator at a point of vantage surrounded by four classes of apparatus. Thus located he may with few steps survey his entire field; look down upon switches, bus-bars, and arresters of the high-tension; see at a glance every low-pressure switch, or watch trouble in either transformer room.

At the generating station the corresponding vantage point is the gallery, where on one side the operator has the motor-driven rheostats and a few paces

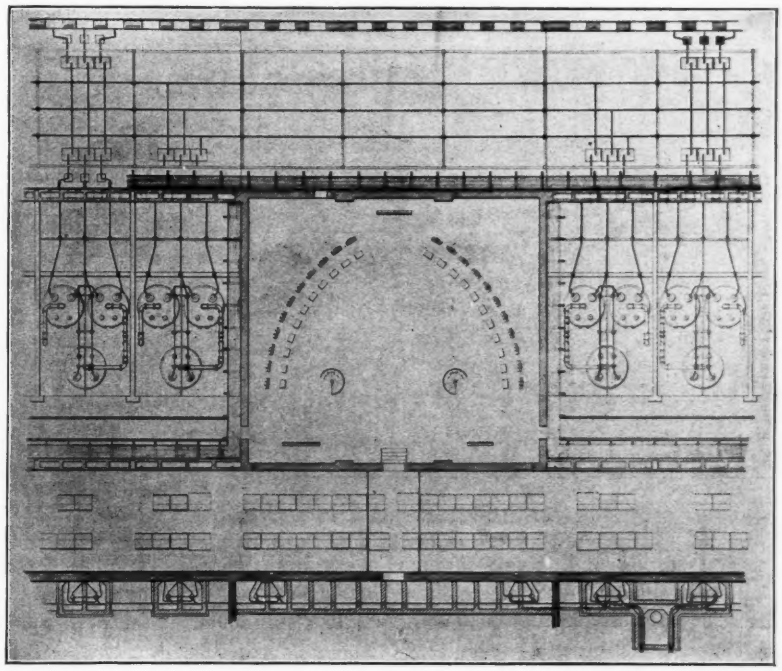


FIG. 9.—PLAN OF CENTRAL PORTION OF DISTRIBUTING STATION, ONTARIO POWER COMPANY.

distant the commutators and governors of the exciters, and on the other side in plain sight the row of main governors with their adjuncts; while from the little switchboard before him he has electrical control of penstock gates and, when necessary, manual control of turbine speeds, exciter pressure and field charge. Moreover, from this position he can see all generators and turbines and, by signal at least, can direct his assistants; little, in fact, is likely to call him to the main floor unless it be an occasional refractory journal or collector brush.

In accomplishing the centralization of switchboard simultaneously with the broad and symmetrical distribution of main circuits and switches already described, distant electrical measurement and control have necessarily been employed to an unusual extent. Pressure and current transformers, essential to the many instruments and relays beyond those necessary at generating station and high-pressure room, are mounted in the bus-bar chamber. The innumerable and long conductors, necessary to extend over the intervening distance from those to the many instruments of the switchboard and to convey back the power from relays and control-buttons to automatic switches, have been gathered into substantial cables and laid in metal conduit.

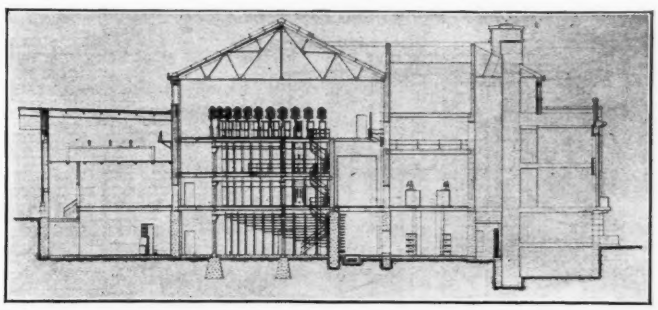


FIG. 10.—SECTION THROUGH CONTROL CHAMBERS, ONTARIO POWER COMPANY.

The basement of the central bay along the side next the low-pressure side forms a wiring-chamber supporting a railway track upon the main floor above. Through this wiring-chamber transverse to the general direction of the main cables and opening at its centre into the control sec-

tion, these cables and those for both continuous and alternating-current local service are carried into the basement beneath the control section and, rising through the recording floors, end at terminal boards below their respective instruments and relays. Carried thus far, distant control has been still further applied by the use of motor-driven rheostats for both generators and exciters, electrically operated circuit-breakers for field circuits and speed controllers for governors whereby, as previously mentioned, turbines may be started, stopped or regulated from the control chamber as well as from the gallery at the generating station.

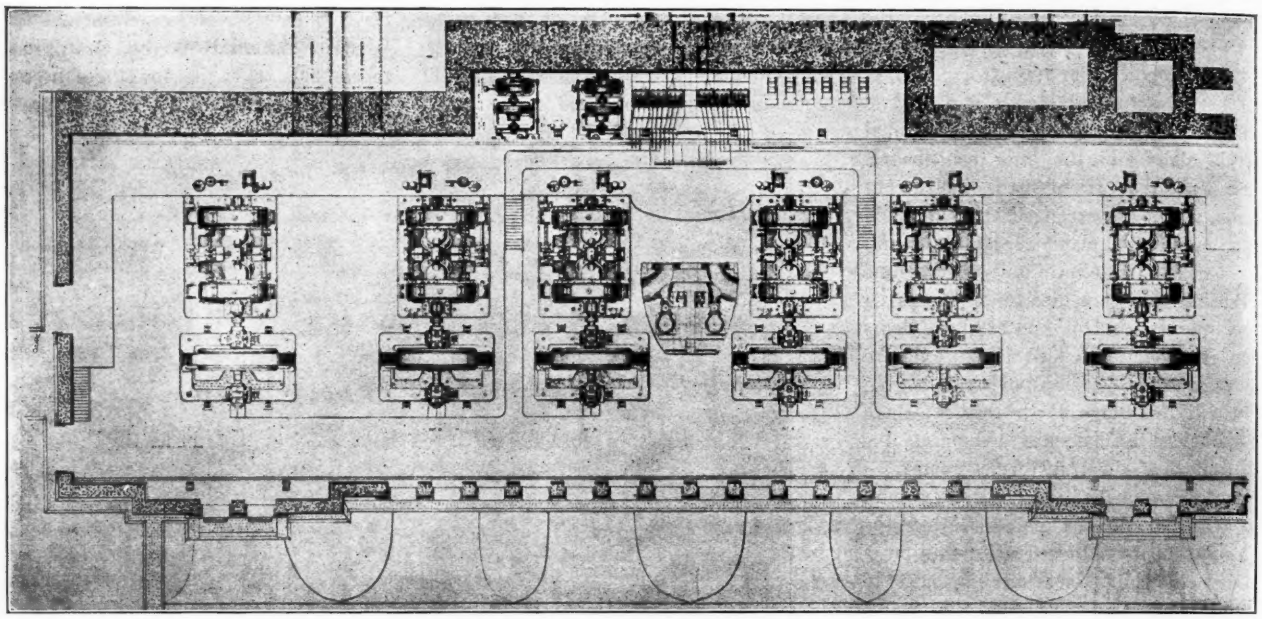


FIG. 11.—PLAN. FIRST SECTION OF GENERATING STATION, ONTARIO POWER COMPANY.

The isolation of electrical apparatus and conductors by incombustible walls or barriers against spread of oil or arcs, for protection from fire and from each other, is of importance proportional to the power and investment involved. Neglect of this precaution has caused many of the most disastrous electrical accidents and has recently taught several bitter lessons. Some rather extreme measures here taken for its more complete application may be of interest. The five sections or rooms, heretofore mentioned, forming the distributing station, are of concrete-and-steel fireproof construction, separated by full-height masonry walls with intervening air-spaces. No windows and but few door-

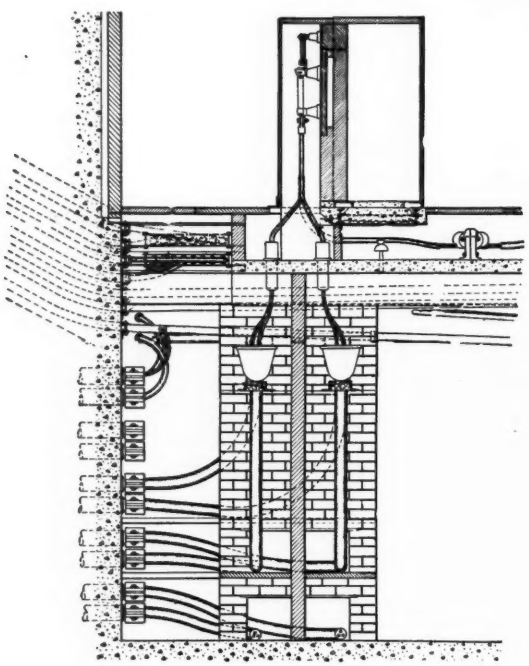


FIG. 12.—CABLE BELL, COMPARTMENTS AND BARRIERS, ONTARIO POWER COMPANY.

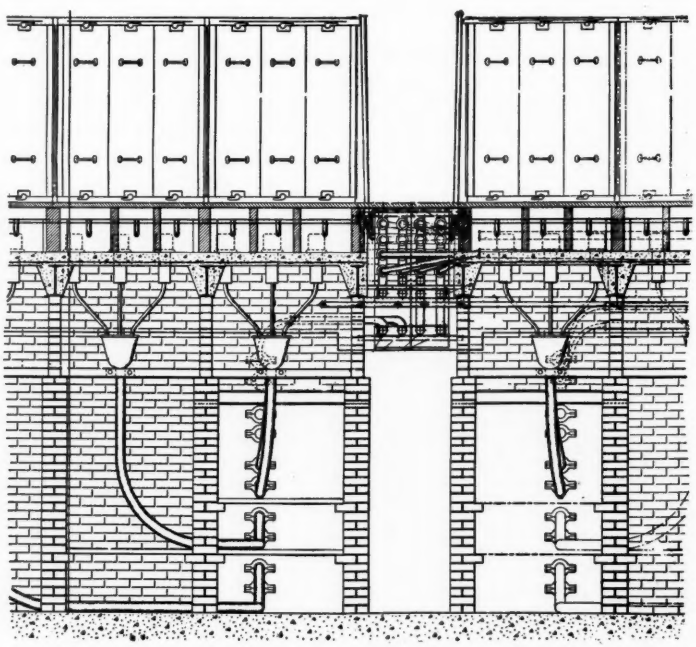


FIG. 13.—CABLE BELL, COMPARTMENTS AND BARRIERS, ONTARIO POWER COMPANY.

ways (these latter protected by fireproof doors, generally closed) penetrate these walls.

The transformer pits already mentioned, each containing a bank of three transformers, are isolated and extended to a height of twenty-three feet by masonry fire-walls. Each individual transformer is in a boiler-iron casing designed to withstand 150 pounds per square inch explosive pressure. Each case communicates through an eight-inch pipe from its top with a special drain for free vent in case of accident, as proposed before the Institute some time ago; but here the supply is cold oil instead of water as then proposed. With these precautions it is believed that the transformers have been surrounded with an environment unprecedented as to safety.

The power from each generator is conducted to its switch through three single-conductor braided cables carried by line insulators and isolated by shelf barriers in a subway beneath the floor. From the switches the three conductors pass to a cell chamber where between individual barriers they are united into two parallel three-conductor lead-covered and armored cables before entering the tile ducts of the cable tunnel. Around the few bends at manholes each cable remains always within its compartment, between horizontal or vertical barriers as required. At each point where a circuit enters the distributing station, a manhole maintaining the same segregation and communicating with the bus-bar chamber is provided for the change from three-conductor to single-conductor cable. After entering the building the cables pass between vertical barriers as before, beneath and through the floor to the switches above.

Bus-bar structures are composed entirely of concrete with mortised reenforced concrete shelf-barriers between buses. Connecting leads pass through the wall forming the centre of the structure, and thence in compartments formed by vertical barriers of the same material, directly up to the switches above. Instrument transformers are also installed within similar individual compartments and these whole structures like those of the switches are closed by fireproof doors. Control cables are laid in metal conduit throughout their courses except in the wiring-chamber beneath the track where they are arranged upon metal shelf pans filled with dry sand into which connecting conduits dip.

Of the features here presented, it is believed that the type of intake, the symmetry of arrangement, centralization of control, and almost perfect isolation of apparatus represent, to some degree at least, distinct advances in power-plant design; and while few works of such dimensions may be built for many years, if ever, it is possible that in a way some of the purposes and methods thus briefly presented may, until superseded by the next advance, be of some service as suggestions to other designing engineers of similar works. The unusual, even enormous, volumes, both of water and of power, involved not only in the individual units but also in the aggregate, have presented new problems heretofore unprovided for in standard sizes of apparatus, thus necessitating the development of larger capacities and the creation of new types. Hence the work of designing and building has been burdened with incessant test, redesign, and adaptation unknown in more conventional engineering. Therefore, it is believed that upon no similar work in this country, since that of the Niagara Falls Power Company years ago in the infancy of electrical power, has devolved such a burden of investigation, invention and original design.

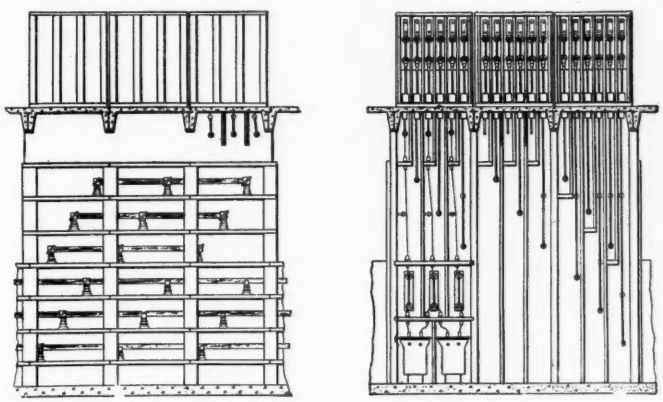


FIG. 14.—FRONT AND REAR OF BUS-BAR STRUCTURES AND SWITCHES.

It has been suggested by an officer of the Institute that any account of this work would be incomplete without mention of those mainly responsible for it. Justice to all is here impossible, but a few may be named. Mr. O. B. Suhr has from the beginning been in charge of the engineer corps and to him is largely due the harmony of design. Mr. V. G. Converse, Mr. C. H. Mitchell, and Mr. J. B. Bailey are chiefs of the electrical, mechanical and field departments respectively, and Mr. J. R. Harsch of the clerical work of the engineers. But more than all else in the establishment of this great and daring enterprise stands out the attitude maintained toward their engineers by Messrs. J. J. Albright and Edmund Hayes, the originators and majority owners, who, in strong contrast with the harassing interference by which uninformed investors frequently spoil the best efforts of engineers, have in this case given not only absolute freedom of action but also steadfast support.

Current Limiters.

A description is given in *L'Electricien,* Paris, by M. L. De Kermond of an overload relay designed to control the action of a fuse. The device consists of a wire through which the current to be controlled passes, and the expansion of which, when heated, allows it to be drawn to one side by a spring. This side motion of the wire closes two contacts one after the other. Around the ordinary fuse is placed a heating coil. The fuse carries the whole current in the usual way, but is large enough to bear a considerable overload. If, now, a slight overload is thrown upon the system, the hot wire expands and a contact is closed which sends the current through the heating coil connected in series with the resistance. By this arrangement the fuse will be melted in about five minutes when the load exceeds the normal by a few per cent. If an excessive load is thrown on—say twenty per cent above the normal—the expansion of the hot wire is so great that the second contact is closed, and this cuts out the resistance in the heating circuit and melts the fuse in thirty or forty seconds. When the fuse melts the circuit is opened, and the hot wire in cooling cuts out the heating circuits. The device is applicable for both direct and alternating-current circuits.

Electrical Notes from Europe.

By Our Special Correspondent.

A PROJECT which is attracting considerable attention is the use of electric traction on the railroad line running along the Mediterranean coast between Nice and the Italian frontier. The question has been discussed for some time past, and the railroad company seems to be favorably disposed toward adopting the electric system. The principal promoter of the idea is M. Réné Auvert, who is one of the leading engineers of the Paris-Lyons-Mediterranean Railroad Company. There are several large hydraulic plants in the region which could be called upon to furnish a sufficient amount of power for operating the line. One point which needs to be determined is the cost of the electric power which the stations would supply to the road. As regards the method of traction to be used in this case, M. Auvert is in favor of adopting electric locomotives to draw the trains, and he has already designed a type of locomotive which would suit the purpose. On the other hand, a system of light trains could be used, in order to cut down the dead weight, employing in this case a type of motor car with trailers. As there are many tunnels along the road in this region, the electric system would be of great advantage as regards lack of smoke, not to mention the other well-known advantages which it possesses.

The Observatory of the Bureau of Longitudes, of Paris, is adopting a new method of time distribution by telephone. It is intended to be used in regulating chronometers and clocks throughout the city in watchmaking and scientific establishments, and no doubt it will be of considerable value. At the Observatory, a standard clock has a microphone placed inside of the case, which receives the shock caused by the clockwork. The microphone is connected to the city telephone circuit, and thus a subscriber can receive the time regulation in order to adjust his chronometers or clocks. This can easily be done by counting the beats, and the exact time corresponding to the first beat is given by the voice through the telephone. It will be noted that the microphone is operated simply by the mechanical shock, and there is no direct electrical connection attached to the clock. Even the slightest electric contact made by the clock might have an effect upon its movement, and thus put it out of order, especially in the case of a standard clock which has to be regulated within one one-thousandth of a second. With the use of the microphone, no such errors could be introduced. The method could also be used for astronomical work between two observations, which by noting the beat could be made to work together by means of a single clock.

A congress of radiology and ionization forms one of the features of the International Exposition which is to be held at Liège. This is the first congress of the kind. The Belgian government has a part in the organization, and many of the leading officials are represented on the committee. The congress is to be held from September 12 to 14 next. Among the questions which are to be studied as regards the physical and biological action of radium rays and kindred effects, is the study of different kinds of radiation, the radioactive properties of water and soils, minerals containing radium, meteorological and astronomical phenomena which may be attributed to ionization and different radiators. A special committee of eminent physicists, headed by M. Henri Becquerel, will examine the questions or papers which are submitted to the congress. Apparatus are to be exhibited on this occasion, which bear relation to the subject. The address of the secretary is Dr. J. Daniel, general secretary, Rue de la Prévôté, Brussels.

In a paper which he recently read before the Société des Ingénieurs Civils, M. Guillet treats of the magnetic properties of alloys. When an alloy is formed of a magnetic metal with a non-magnetic metal, sometimes we obtain a magnetic alloy. This is true in the case of an iron-aluminum alloy, where the proportion of the latter is less than twenty per cent, also for an iron and copper alloy where the copper figures for less than sixty per cent. In other cases we have a non-magnetic alloy. It is observed that two magnetic metals generally give a magnetic alloy, and we find that all the alloys of cobalt and nickel or iron and cobalt are magnetic. In the case of iron and nickel we sometimes obtain non-magnetic alloys. As regards the action of non-magnetic metals, we find that they generally afford a non-magnetic alloy, as might be expected, but some exceptions to this rule have recently been found by German experimenters, using manganese and aluminum, or tin and antimony. M. Guillot considers that the most likely theory as to the action of the non-magnetic metals in such cases is to admit that manganese has magnetic properties at a low temperature and that aluminum and other metals are able to raise the point at which it is still magnetic, so as to bring this point to the ordinary temperature or still higher. It may also be possible that chromium is magnetic at a low temperature.

A Hamburg company is preparing to manufacture the new insulating compound known as "galalith" on a large scale. This compound is formed from the casein of milk, and it is said to have insulating properties which render it nearly as good as ebonite. The compound is obtained in the form of a plastic mass, which is then pressed into any form which may be desired. Galalith is more elastic than ebonite and it can be worked very well with a tool. It is stated that in regard to insulation and resistance to spark discharge it is hardly inferior to ebonite. This has been shown by a series of official tests which was made not long ago with the new substance at the Imperial Laboratory of Berlin and the State Laboratory of Hanover. It seems that it can not be attacked by oil, benzine or alkalies. A pound of the compound requires about eight gallons of milk to start with. The company which is beginning to manufacture it has made a contract to receive five million gallons of milk, so that in one year it can produce 150,000 pounds of galalith.

The Grenoble Electric Light and Power Company has submitted a project for replacing steam trains by the electric system on a section of railroad starting from Grenoble. It proposes to use it in the first place between the stations of Sassenage and Veurey, on that section, and also on the line which connects this road with the Paris, Lyons & Mediterranean Railroad.

Radium salts are now on the market in Europe. A large works near Paris, which has already furnished a considerable amount of radium compounds to M. Curie, is now equipped for treating the residues on a large scale and is prepared to take orders for these compounds. As to the price which is asked at present,

we note the following: as regards the activity of the salts on which their cost naturally depends, it is estimated by taking metallic uranium as unity of comparison. Radium salts having an activity of 100 thus costs forty francs (eight dollars) per gramme. This activity is very low, however. Salts which show the properties of radium in a high degree and whose activity is reckoned at 50,000 times that of uranium bring a price of 10,000 francs ($2,000) per gramme, while at an activity of 500,000, the price is as high as 100,000 francs ($20,000) per gramme.

At Klagenfurt, in Austro-Hungary, the electric process of pipe-thawing is used somewhat extensively by the inhabitants. The winters in this region are very severe and the pipes are often frozen. The Hubner-Messimer electric firm adopted a system which has proven very successful. A fifty-ampere transformer is installed in a convenient place near the electric lines and it is connected by two fuses to an ammeter which measures the current consumed, and a rheostat. The wires from the secondary of the transformer are run to two points on the pipe which is to be thawed out. A pipe 150 feet long and half an inch in diameter can be thawed in three hours, using a current of fifty amperes and 110 volts.

The telegraphic administration of Holland has lately made a decision as regards the installing of aerial telegraphy posts in the Dutch East Indies. The government will not undertake such operations, but is to grant concessions for aerial telegraphy to a private company which has been lately formed for the purpose. At the head of the company are two government representatives. The choice of the system and the kind of apparatus which is to be used in this case have been left to the company, which is free to select whatever apparatus seems the best. The present decision has caused some comment, seeing that the government has heretofore taken an active interest in telegraph matters in the East Indies. In 1902 it allowed a subsidy to the company which owned the telegraph cable running from Auam to Menado and placed this cable under the protection and surveillance of the state. The above-mentioned cable had the advantage of making these islands independent of the British cable. The policy which was adopted in regard to the telegraph seems to be contradicted by the recent decision as to aerial telegraphy and especially as the latter will no doubt prove of great advantage in communicating between the islands.

A new method of forming very fine wires by an electrolytic treatment has been recently brought out at Paris by H. Abraham, a well-known physicist. The process consists in diminishing the section of a wire by using it as a soluble anode in an electrolytic cell. The resistance of the wire is taken at intervals and this gives an idea of the rate at which the section is diminished. The action is thus controlled and the current is cut off when the proper point has been reached. However, in order to obtain a regular section of the wire by this process, we must observe certain precautions. In the first place, the bath must be very dilute and have a high resistance so as to give a uniform distribution of current over all the length of the wire. This also allows some latitude in placing the two electrodes and they need not be given an exactly defined position. The best solution seems to be distilled water containing a few thousandths by weight of copper sulphate, or for silver wires, nitrate of silver can be used. Second, the operation should be carried out very slowly, so that the salt which forms around the wire will have time to diffuse in the bath. If this point is not observed, the bath becomes conducting to a great extent when the current is high, and the wire is broken. The current density to be used here is on the order of 0.01 ampere per square centimetre surface of the wire. It is well to cut down the current density as the section of the wire diminishes. The experiment can be made very conveniently in a porcelain dish such as is used in photography. Here the wire can be seen readily. It is suspended by the ends from glass hooks and is soldered at the ends to two metal rods which lie outside the bath so as to avoid local circuits.

The use of chemically treated arc carbons is increasing in many of the leading cities of Europe. In this case the carbons are either impregnated with a solution of certain salts, or they are cored, and the salts in a solid form are placed in the inside of the carbon. The Bremer carbon is one of the most successful of these systems, and it gives a very brilliant and at the same time agreeable light which has a mellow hue and is not as trying to the eye as the ordinary arc light. In this case the carbon is treated with a fluoride of calcium solution. Besides the advantage as to the quality of the light, it is claimed that the Bremer carbon shows the highest efficiency which has yet been obtained for an arc lamp, or 0.1 watt per candle-power. This form of lamp is generally used with a tight globe. It runs on ninety volts in some of the standard lamps. The light which it gives is of a yellowish color.

A wireless telegraph construction firm of Germany recently built four portable stations for the military service. These stations are to be used in South Africa. They are stated to cover a distance of 200 miles or more. Two stations of a much larger capacity are now constructing for Russia and are soon to be finished. Here the distance is some 600 miles. The Telegraph Administration of Holland is also having an aerial telegraph station built, which is to work over a distance of 250 miles or more.

C. L. DURAND.

Paris, July 8.

BOOK REVIEW.

"American Street Railway Investments." New York. McGraw Publishing Company. Cloth. 415 pages. 10 by 13¼ inches. Supplied by the ELECTRICAL REVIEW at $5.

This is the twelfth annual edition of this manual, which is recognized as an authority on financial statistics of American street railway companies. The book is fifty-three pages larger than the edition of 1904. This increase has been due in part to the addition of reports from new roads, but more largely to the fact that many roads have furnished a statement of earnings this year from which such figures have not been obtainable heretofore. Among the new features in the manual this year is an increase in the index, which is bound in the back of the book. Heretofore only the names of the companies reported have been included in the index. This year the index has been enlarged to include the names of all underlying companies which have bonds outstanding, even though the company may not at this time have any separate corporate existence. This enables investors to refer readily to the report of the company which now operates the road of any former company. The introduction to the book contains a summary of the gross receipts for the last two years of the principal companies reporting. As there have been many consolidations during 1904, this table is not an exact index of the growth of the business, as the figures, in a number of cases, represent receipts for a larger amount of trackage. Nevertheless, the increase is such a steady one as to indicate a substantial gain in street railway earnings for the past year.

ALTERNATE CURRENT MACHINERY—INDUCTION ALTERNATORS.[1]

BY WM. STANLEY ASSISTED BY G. FACCIOLI.

In the following pages it is proposed to discuss some of the elementary phenomena found while studying the performance of alternators excited by alternating currents. The alternators have their rotors and stators wound with distributed windings. The rotor circuits are supplied with very low frequency, multiphase currents, as shown in Fig. 1. These currents produce a field, or fields, which move around the rotor at a speed proportional to the frequency of the magnetizing or exciting source.

If the connection of the multiphase exciter is such as to produce a clockwise electromagnetic rotation of the field (rotor), the rotor structure of the alternator may then be mechanically revolved either in the same or in an opposite direction.

Let n be the frequency of the exciting circuit and n_1 the frequency of mechanical rotation; then if the electromagnetic and mechanical rotations are in the same direction the speed of the flux will be proportional to $n_1 + n$; if they are in opposite direction to $n_1 - n$, and, as will be shown, these two relative arrangements produce very different phenomena.

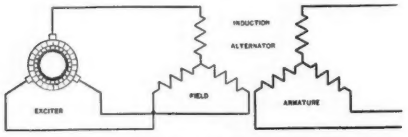


FIG. 1.—INDUCTION ALTERNATOR CIRCUITS.

Call $n_1 + n$ or $n_1 - n = n_{11}$ = the frequency of the currents induced in the stator or armature conductors of the machine, evidently when $n = n_1$, $n_1 - n = 0$, and there is a stationary field in the space opposite to the stationary armature conductors; consequently no electromotive force is induced.

Suppose, however, that n is small compared to n_1; for example, let the exciting frequency $n = 1$ cycle, while the frequency of rotation $n_1 = 61$ cycles; then

$n_1 - n = 60$ cycles.

$n_1 + n = 62$ cycles.

Consider the first case for a moment. Suppose the stator, or armature, of the alternator is supplying current to an external circuit; then, if we have a clockwise rotation (revolutions per minute) of sixty-one cycles and a counter-clockwise electromagnetic rotation (exciting current) of one cycle, the effective field rotation is clockwise and sixty cycles; consequently, the armature (stator) currents are also of sixty cycles frequency. But these stator currents produce a field in the air-gap of the machine and this field revolves synchronously with the rotor induction, but not synchronously with the rotor conductors, for they (the conductors) are going faster, *viz.*, at the rate of sixty-one cycles. They are therefore constantly overtaking the stator-produced field, and passing through it. That is to say, cutting it, and they therefore have electromotive force induced in them of a frequency = 61 — 60 cycles = 1 = n, the exciting frequency; the final result being that an electromotive force of the same frequency as that of the exciting current is produced in the rotor (field) conductors, by simply loading the alternator in the usual manner.

This "stator-induced electromotive force" in the rotor conductors is evidently proportional to, and in quadrature with, the stator current. It is zero when the stator current is maximum, maximum when the stator current is zero, etc. It is of the utmost importance in the phenomena to be described, for if the rotor circuit be of low resistance (great time-constant) the "stator-induced electromotive force" in the rotor will produce a current (called "stator-induced current") approximately equal in value, nearly opposite in phase to the stator current and, consequently, competent to neutralize the magnetomotive force of the armature or stator circuit and to destroy almost completely the magnetization due to the stator winding. In such an alternator there should be, then, no armature reaction, no back magnetization, no distortion of the field of the machine.

At first sight it would seem that these machines should give a constant electromotive force at all loads; when excited at constant potential they do not do this, but they give, when properly designed, a gradually rising potential at power-factor = 1 with a slight drop of potential for lower power-factors down to power-factor = 0.

In Figs. 2 and 3, Mr. Faccioli has represented the phase relations of the electromotive force, currents, etc., when (Fig. 2) the effective frequency of the alternator is equal to the difference between the rotational and magnetizing frequencies, and (Fig. 3) when it is equal to their sum.

In the diagram here given the ratio of the rotor to the stator turns is assumed to be 1: 1; the ohmic and inductive resistance of the exciter is zero, that is to say, the exciter is assumed to maintain a constant terminal potential.

In the case of Fig. 2 ($N_{11} = N_1 - N$) the flux of the alternator rotates in one direction regarding the rotor and in the opposite direction regarding the stator; therefore the diagram is supposed to rotate in the direction R regarding the rotor and in the direction S regarding the stator.

v is the leakage coefficient of the rotor; that is, the ratio between the flux produced by the rotor which enters the stator and the total flux set up by the rotor. The leakage coefficient of the stator is assumed to be equal to the leakage coefficient of the rotor.

E_x represents the electromotive force of the exciter (low frequency) which is supplied to the terminals of the rotor and is assumed as constant for any load of the machine. i_0 is the magnetizing current of the machine at no load and lags behind E_x by the angle ϕ; ϕ being a function of the resistance of the rotor and the frequency of excitation.

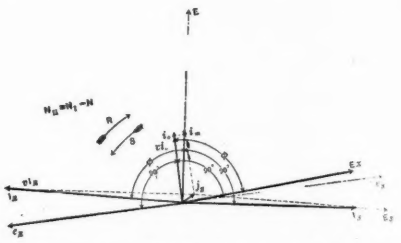


FIG. 2.—PHASE RELATIONS WITH BACKWARD ELECTROMAGNETIC ROTATION.

At no load the flux set up by i_0 will induce an electromotive force e_R of the terminals of the rotor; a part of the same flux proportional to $v\ i_0$, will induce an electromotive force e_s at the terminals of the stator.

Now consider the case in which the machine is loaded by the current I_s at power-factor unity. The current I_s of the stator (armature) induces at the terminals of the rotor (field) an electromotive force in the direction of E, proportional to the frequency of excitation of the machine. The electromotive force E produces in the rotor a current I_R which lags behind E by the angle ϕ. I_s and $v\ I_R$ give a resultant j_s, whose magnetomotive force is superimposed on the original magnetomotive force $v\ i_0$, giving a resultant magnetomotive force i_m, which is in quadrature with I_s. The electromotive force of the stator is E_s in quadrature with i_m and therefore in phase with I_s.

In the case of Fig. 3 when ($N_{11} = N + N_1$), the diagram rotates in the same direction regarding the stator and the rotor. The same symbols represent

[1] Abstract of paper presented at the twenty-second annual convention of the American Institute of Electrical Engineers, Asheville, N. C., June 23, 1905.

the same quantities as in Fig. 2. In this case the electromotive force e_s and e_R have the same direction, and the resultant magnetomotive force j_s has such direction as to decrease the original magnetization $v\ i_0$ of the machine; while in the case of Fig. 2, the magnetomotive force j_s, due to the load currents, has the effect of increasing the no-load magnetization of the machine.

When, therefore, the generated frequency of the machine is equal to the difference of the frequency of rotation

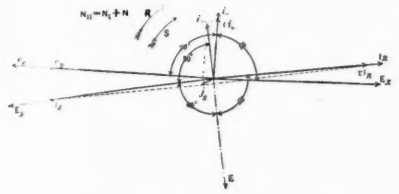


FIG. 3.—PHASE RELATIONS WITH FORWARD ELECTROMAGNETIC ROTATION.

and the frequency of excitation, the magnetization of the machine may be higher when loaded with non-inductive load than when running free; this result being principally due to the resistance of the rotor or field, which prevents the current I_R from lagging exactly ninety degrees behind E and consequently neutralizing the magnetomotive force of I_s.

On the other hand, the resistance of the rotor when the generated frequency is equal to the sum of the frequency of rotation and the frequency of excitation, has the effect of decreasing the magnetization of the machine when loaded with non-inductive load.

If the rotor of the machine had zero resistance and perfect mutual induction, then the rotor current I_R would lag exactly ninety degrees from its electromotive force in both Fig. 2 and Fig. 3, and would be exactly equal and opposite to the stator current I_s. There would be no resultant magnetomotive force due to the load and therefore j_s would be equal to zero and the machine would have constant electromotive force at any load and at any power-factor.

It then appears that if a machine of this type, that is, a machine with almost perfect mutual induction and very low resistance, could be built, there would be very little difference in its regulation when excited by forward and backward running fields. The principal difference would consist in the fact that with a forward running excitation the exciter would supply energy to the alternator in proportion to the ratio of the exciting to the generated frequency, while with the backward running excitation, the exciter delivers no energy to the alternator but receives energy from it.

Fig. 4 shows the regulation of the induction alternator at different frequencies of excitation. The curves belong to a 100-kilowatt, eight-pole, sixty-cycle, 900 effective revolutions per minute machine built by the Crocker-Wheeler Company for experimental purposes; Figs. 2 and 3 refer to the same machine. The curves of Fig. 4 are in perfect accord with the actual tests made on the machine, the results of which are given later on.

This figure shows that for each machine, that is, for each combination of resistance and leakage in any machine, there is a certain frequency of excitation below which trifling changes in the constants of the alternator produce great changes in its potential characteristics. For small high-frequency machines an exciting frequency of about five cycles may be required, while on large machines in which the resistance and leakage may be relatively lower, the exciting frequency may be as low as one cycle.

In a similar way it is possible to study the influence of the variations in the ex-

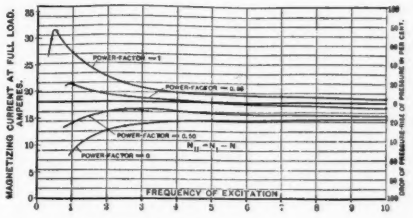

MAGNETIZING CURRENT AT FULL LOAD, AMPERES
POWER-FACTOR = 1
POWER-FACTOR = 0.90
POWER-FACTOR = 0.50
POWER-FACTOR = 0
$N_0 = N_1 - N$
FREQUENCY OF EXCITATION
DROP OF PRESSURE IN PER CENT.

FIG. 4.—REGULATION CURVES OF 100-KILOWATT, 900 EFFECTIVE REVOLUTIONS PER MINUTE, 60-CYCLE INDUCTION GENERATOR.

citing frequency in the case of the forward rotation of the field. Fig. 5 gives the regulation of the same 100-kilowatt alternator at different power-factors for different frequencies of the field. The curves in Fig. 5 show that in the case of forward rotation of the field the potential of the alternator will drop at any power-factor, due to the effect of the resistance and leakage; but the difference in regulation between power-factor unity and lower power-factors is very small in comparison, with the results obtainable with the alternators of standard type. (The phenomena in this machine are magnified by the high resistance of the rotor.)

The variation of the air-gap in these machines has a peculiar influence on their regulation. Doubling the air-gap of the same machine has very little effect on its regulation at the frequency which is used for its excitation (about five cycles). This is due to the fact that any increase in the air-gap involves an increase in the no-load magnetizing current of the machine, and an increase of the leakage coefficient v, and these two phenomena have conflicting influences on the regulation of the alternator.

When, however, the leakage of the machine is comparatively low, as in the case of high-speed alternators with a small number of poles, and the no-load magnetizing current is high (large air-gap) then something is gained in regulation by increasing the length of the air-gap. For instance, this is the case with turbine alternators where a large air-gap is required for mechanical reasons.

Considering now the phenomena of the system, the following general conditions are found: the current in the exciting circuit is composed of two parts or components. First, that due to the exciter electromotive force, which is the no-load magnetizing current; secondly, the current due to the electromotive force generated in the field (rotor) conductors by the stator load current. The first of these, the no-load magnetizing current (volt-amperes), is for any given capacity of the alternator, inversely proportional to its speed; that is, is proportional to the number of poles of the alternator for any given generated frequency, or is proportional to the frequency of the alternator driven at constant speed.

This magnetizing apparent energy is therefore small with high-speed machines of given frequency, and small with low-frequency machines of given speed; consequently, it is smallest in low-frequency turbine alternators and is larger in slow-speed direct-connected high-frequency machines. It is to be remembered, however, that the magnetizing current is only a fractional part of the full-load current in the exciting circuit; therefore it is

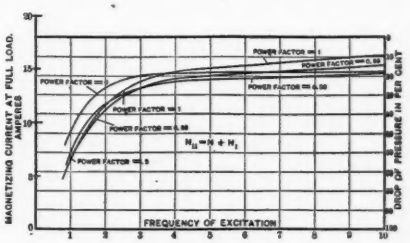

MAGNETIZING CURRENT AT FULL LOAD, AMPERES
POWER-FACTOR = 1
POWER-FACTOR = 0.90
POWER-FACTOR = 0.50
POWER-FACTOR = 0
$N_0 = N + N_1$
FREQUENCY OF EXCITATION
DROP OF PRESSURE IN PER CENT.

FIG. 5.—REGULATION CURVES OF 100-KILOWATT, 900 EFFECTIVE REVOLUTIONS PER MINUTE, 60-CYCLE INDUCTION GENERATOR.

not necessarily a limiting condition and does not determine the size of the exciter.

The second component of the exciting current is the superimposed component, and is approximately equal in total amperes to the armature current of the alternator. The electromotive force of the

exciter is proportional to the electromotive force of the alternator multiplied by the ratio of the exciting to the generated frequency. The two components of the exciting current (the magnetizing and superimposed) have the following phase relations.

When the alternator is delivering current at power-factor unity, the magnetizing and superimposed components are nearly in quadrature; when the alternator delivers current at power-factor zero, the components are nearly in phase.

If we call M the no-load magnetizing volt-amperes of the exciter, N_1 the frequency of excitation, N_{11} the generated frequency of the alternator, w the capacity of the alternator in kilovolt-amperes, we have the size of the exciter approximately proportional to

$$\sqrt{M^2 + W^2 \frac{N_1^2}{N_{11}^2} + 2\,MW \frac{N_1}{N_{11}} \sin\phi};$$

ϕ being the maximum angle of lag of the current that the alternator is called upon to deliver.

Thus, if the alternator is a 100-kilowatt, twenty-five-cycle machine excited at a frequency of 2.5 cycles, and the no-load magnetizing volt-amperes are five kilovolt-amperes, and if the alternator is called upon to deliver its full-load current at power-factor 0.5, the size of the exciter is:

$$\sqrt{5^2 + \left(100\,\frac{2.5}{25}\right)^2 + 2 \times 5 \times 100\,\frac{2.5}{25} \times 0.86} = 14.5 \text{ kilovolt-amperes.}$$

It will then be seen that the exciter is called upon to carry a current practically equal in total amperes to the load current of the alternator, the apparent energy of which is dependent on the frequency of excitation; consequently, the aim of the engineer is to so design his machines that they will require the minimum exciting frequency.

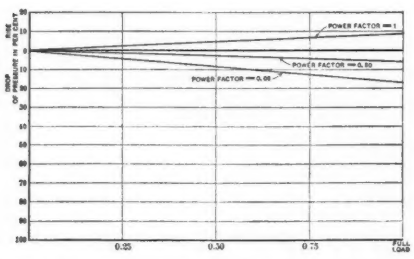


FIG. 6.—REGULATION CURVES OF 100-KILOWATT, 900 EFFECTIVE REVOLUTIONS PER MINUTE, 60-CYCLE INDUCTION GENERATOR.

Fig. 6 shows the regulation curves obtained from tests of the 100-kilowatt, eight-pole, sixty-cycle, 900 effective revolutions per minute alternator above mentioned, as a function of the load of the machine when its field is excited by five-cycle current at constant potential (backward rotating field). For full load of alternator at power-factor 0.8 the size of the exciter is thirteen kilovolt-amperes, or thirteen per cent of the size of the alternator. The curves agree very closely with the calculated characteristics of the alternator.

Fig. 7 refers to a 1,500-kilowatt, twenty-five-cycle, 1,500 effective revolutions per minute turbine alternator. The frequency of excitation is 0.75 cycle and the exciter at full load of the alternator, power-factor 0.8, has a capacity of ninety-five kilovolt-amperes; that is, 6.5 per cent of the size of the alternator.

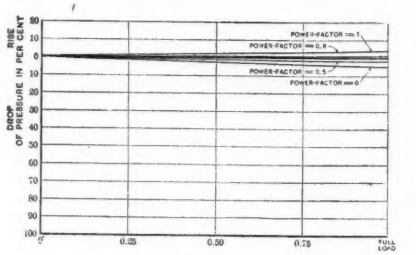


FIG. 7.—REGULATION CURVES OF 1,500-KILOWATT, 1,500 EFFECTIVE REVOLUTIONS PER MINUTE, 25-CYCLE INDUCTION TURBINE ALTERNATOR.

Fig. 8 gives the exciting watts for different loads of the 100-kilowatt, sixty-cycle, eight-pole alternator (at unity and lower power-factors). As shown by these curves, the energy delivered to the alternator at no load is small and positive. As the alternator-load increases, the current in the rotor magnetizing circuit increases, but the watts fall to zero and reverse; that is, the current in the rotor-exciter circuit lags until it exceeds ninety degrees behind the exciter electromotive force; it therefore flows through the exciter against the exciter's electromotive force, just as a current delivered by a generator flows through a motor circuit against the counter-electromotive force of the motor.

The all-important factor in the design of induction alternators is then the excitation.

At first sight, the designing of an efficient and economical exciter to deliver multiphase exciting currents of five cycles or lower frequency, would appear to be an almost hopeless undertaking; for if an exciter of, say, three-cycle frequency and fifty kilovolt-amperes is necessary to furnish the field and controlling current for a 500-kilowatt alternator, working on old lines, we should be compelled to design a two-pole machine of 180 revolutions per minute to deliver fifty kilovolt-amperes at power-factor zero to unity power-factor.

The manufacture of such a machine would ruin any going concern. We are therefore compelled: (1) to find such a method of generating the exciting currents as will permit the use of normal speeds and consequent reduction of size of the exciter; that is, the exciters must be designed to give low frequencies at high speed; (2) to produce the desired potential gradient on the alternator, we must so design the exciter that it will have a characteristic complementary to that of the natural characteristic of the alternator it excites. These are severe conditions to impose upon any machine, but they have been met in a novel manner in the machine about to be described.

It is evident that if the field of an ordinary direct-current machine is slowly alternated, corresponding alternations in the electromotive force of the armature will occur. Such a machine could evidently be driven at any speed and would give alternating current through its commutator and brushes corresponding in frequency to the frequency of its field, but it could furnish single-phase currents only.

It is evident also that two such machines could be coupled on the same shaft, each machine having its field excited by low-frequency and phase-differing currents; and such an arrangement would generate from the two armatures two phase-differing currents, whose frequency is independent of the speed of rotation.

If now these two fields are combined in one machine, that is, if the field is a Ferraris or rotating field instead of a simple periodic field, it is evident that a single armature with a simple commutator and four brushes placed in quadrature around the commutator will deliver two sets of alternating currents, differing in phase by the angle of the brush displacement, and at the same frequency as the rotating field, and that the figuring of the generated currents will be independent of the speed of rotation.

Such an arrangement might be a machine in which the stator consists of a four-pole structure having energizing coils diametrically located on opposite poles and connected to a two-phase source of excitation, while the armature and commutator deliver two-phase currents to external circuits. But this arrangement presupposes and employs a third element

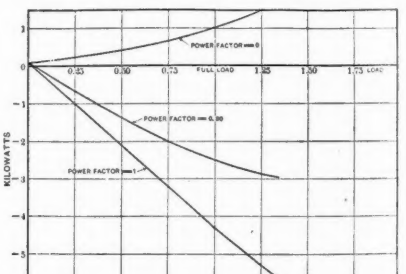


FIG. 8.—EXCITING WATTS FOR DIFFERENT LOADS OF 100-KILOWATT INDUCTION ALTERNATOR.

to furnish the original exciting current of the exciter.

In order to make the exciter self-exciting and self-contained, and to reduce the apparatus to the simplest terms, the following scheme for excitation has been devised, Fig. 9. A pair of brushes corresponding to those of an ordinary generator is connected to a field coil, so located with reference to these brushes that the flux it produces will be displaced by a predetermined angle, dependent upon the number of phases desired. Thus for a two-phase machine a pair of brushes is connected to a field coil so located as to produce a flux, by means of which and by rotation an electromotive force is generated upon the other pair of brushes, while the second pair of brushes is connected to a coil so located as to produce a flux that will generate an electromotive force on the first pair of brushes. This is shown in Fig. 9, which illustrates the connection and operation of self-excitation by means of two and three-phase currents.

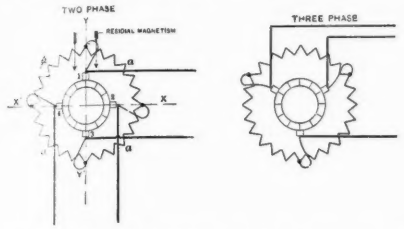


FIG. 9.—SELF-EXCITATION BY TWO AND THREE-PHASE EXCITERS.

Let the residual magnetism of the machine be as shown in the diagram. Then, on rotating the armature, an electromotive force will be developed on brushes 2—4. These brushes are connected to the field winding at X—X^1 instead of at Y—Y^1, as is usual in exciting continuous-current machines, consequently a current will flow, say from X through *a*—*a* to X^1, producing a flux through the armature at ninety degrees to the residual magnetism. A resultant field will therefore lie between the points Y—X and Y^1—X^1, but this field will generate an electromotive force on brushes 1—3 and these brushes will deliver a current through Y—*a*—*a*—Y_1 in such a direction as first to oppose the residual magnetism and afterward reverse its direction. At the instant that the residual magnetism is zero the only field operating in the machine is that due to the currents from the brushes 2—4; subsequently this field combines with the vertical reversed field to brushes Y—Y_1, producing a resultant with polar line between X—Y^1. These operations being cyclic, they recur at periodic intervals, and the phenomena become continuous.

At the resistance of the energizing circuit *a*—*a* is low in comparison with its inductance, the currents delivered from each pair of brushes lag nearly ninety degrees behind the electromotive forces, and therefore little energy is wasted in field excitation. This process of excitation presents many curious and interesting features. If, for example, one of the magnetizing circuits, such as X, be disconnected from the armature, the field immediately dies out, even if there is no current in circuit at the instant of the breaking.

The approximate calculation of the frequency of self-excitation as given by Mr. Faccioli will be found by considering for a moment the physical phenomena that occur.

Assume the speed of rotation of the armature to be n_1; let the machine be a single magnetic-circuit machine with X conductors in the armature, and Y conductors on the stator. A moment's consideration of the laws of induction will show that the direction of the current delivered by the armature to the field must be such as to produce a field rotating in the same direction as the rotation of the armature.

Let the frequency of this rotating field be N, then evidently the effective frequency of the armature conductors will be:

$$N_1 - N = N_{11}$$

We therefore have X armature conductors cut by the flux of the machine at frequency n_{11}, and Y conductors of the field cut by the same flux at frequency N; therefore there will be two electromotive forces; one on the rotor and one on the stator, for each magnetizing circuit; and as is evident the condition of equilibrium of current flow will be obtained when these two electromotive forces are equal and opposite to each other.

This condition of equilibrium will always be fulfilled for a certain frequency of self-excitation; such, in fact, as will make:

$$XN_{11} = YN$$

But $N_{11} = N_1 - N$

so $YN = (XN_1 - N)$

and $N = N_1 \frac{X}{X + Y}$

That is, the frequency of self-excitation will be equal to the frequency of rotation times the turns on the rotor divided by the sum of the turns on the rotor and stator.

By this formula we can easily determine the winding of a machine for a given frequency of self-excitation; for instance, in the case of a two-pole machine in which the speed of rotation is 900 revolutions per minute (fifteen cycles) the number of armature conductors is 200 and the frequency of self-excitation desired is three cycles, we find that the number of turns required on the stator is:

$$\frac{200\ (15 - 3)}{3} = 800$$

Evidently these results are only strictly true when the resistance and leakage of the machine are zero, or not considered, as these quantities have a slightly modifying effect.

When the windings are similarly disposed in rotor and stator it is not necessary to take into consideration the winding distribution coefficients, but the proper coefficients should be employed when the stator has salient poles.

This type of machine satisfies, therefore, the first condition laid down as necessary for a commercial exciter; for it produces low-frequency multiphase currents at normal speeds. It also fulfils the second condition—that it should deliver zero and negative power-factor currents at constant or rising potential with much greater exactness than the ordinary type of alternator; for the reason that the armature reaction of a machine of this type may be made practically zero, because the field of the machine progresses in the same direction as the rotation of the armature and consequently tends to maintain the electromotive force at low power-factor loads, and because it may be compensated to give a positive, potential gradient.

Fig. 10 gives the voltage characteristics of a ten-kilovolt-ampere exciter as a function of the amperes of load for power-factor = 1, and power-factor = 0. The frequency of self-excitation of this machine, when run at 900 revolutions per minute, is five cycles.

An examination of the characteristic curves of the induction alternator ($n_1 - n$) type, Fig. 6, shows that the potential gradient of these machines is positive for load currents of unity power-factor; zero for load currents of (about) power-factor = 0.8 and negative for currents of power-factor = 0.

If, therefore, the exciter is given such a characteristic that the electromotive force of the exciter will be slightly lower when the alternator is full loaded with power-factor = 1 currents, and slightly higher when the alternator is delivering low power-factor currents, the potential of the alternator may be maintained practically constant for any variation in load or power-factor.

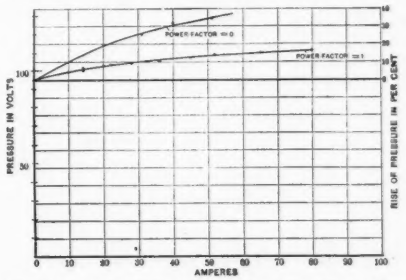


FIG. 10.—VOLTAGE CHARACTERISTICS OF A TEN-KILOVOLT-AMPERE EXCITER.

It is to be remembered that the exciter, when used with ($n_1 - n$ type of alternator), is never called upon to furnish power-factor unity currents, but to receive them, and that the magnetizing reaction of such currents upon the exciter field is exactly the reverse of that found when the power-factor unity currents are delivered; therefore, the exciter should be so designed, when used with this machine, as to give an increase of potential when delivering power-factor unity currents (that it may have a negative potential gradient when receiving them), as well as a slight increase of potential when delivering power-factor zero currents.

Reviews of Current Engineering and Scientific Literature.

Some Applications of the Braun Cathode Ray Tube.

Some useful applications of the Braun cathode ray tube are described here by Messrs. W. M. Varley and W. H. F. Murdock, in which the tube is used for illustrating the form of alternating-current waves. The tube is excited by a Voss machine, the negative pole of which is connected to the cathode. The current flowing was 2×10^{-8} ampere, and the potential corresponded to a spark-gap of about four millimetres. The tube is covered with tinfoil, which should be earthed; and the anode of the tube and the positive pole of the exciting machine should also be connected to the ground. The phosphorescent screen was of mica coated with calcium tungstate. By means of a lens placed in front of this the image may be fixed on a screen for observation or for photographing. Placing coils at right angles to the tube, the spot of light may be deflected, this deflection being used to trace out the wave form to be investigated. Two and three-phase magnetic fields are illustrated by means of two or three coils placed suitably around the tube. Hysteresis curves are obtained by placing two coils at right angles and connecting them in series. In one of these the iron to be studied is inserted. In this the coil gives a deflection proportional to the induction; in the other coil, a deflection proportional to the magnetizing force. The tube may also be used for illustrating oscillatory discharges by means of a revolving mirror.—*Abstracted from the Electrician (London), June* 16.

Some Problems in the Wireless Transmission of Signals.

The present condition of the art of wireless telegraphy is discussed here by Mr. L. H. Walter. The problem which has been solved is the production at a transmitter station of electric waves by the oscillatory discharges of condensers, which waves are caused to influence a responding device at the receiving station far away. When the distance is increased beyond a certain point it becomes necessary either to increase the height of the antenna or the amount of the transmitter energy, or else to make the receiving device more sensitive. Of these alternatives the first would seem to be the best, since doubling the height gives four times the range; but there is a well-recognized limit for the height of the antenna, from practical considerations. Hence has come about the practice of increasing the energy supplied to the transmitter, although certain investigators have endeavored to increase the sensibility of the receiving device. Professor R. A. Fessenden, in particular, has constructed a receiver which requires only 0.007 erg to operate it. The energy required by the ordinary coherer is about four ergs. The former device would seem to be as sensitive as can be desired. Turning, however, to the transmitter, it is seen that the process is wasteful—not that a large amount of energy is lost, but that the amount of useful energy is an exceedingly small part of that sent out by the transmitter. One cause of this is due to the fact that the messages are sent out in all directions instead of being directed. The former is desirable only for ship distress signals. For other purposes it has a distinct disadvantage. In addition to this great loss it is found that the transmitting device itself is inefficient, for of several hundred watts employed at the sending station, only about ten per cent is converted into electric waves and is useful. From these considerations the author believes that it seems more worth while to study how best to develop the transmitter and the transmitting medium rather than the receiver, which has been more perfectly developed. In this connection reference is made to Artom's work, who claims that he has been able to set up a polarized beam of electric waves. If these results are correct, instead of throwing into vibration the medium surrounding the transmitter station in a circle of 180 kilometres radius, it would seem that he excites an elliptical area about 260 kilometres long and 100 kilometres wide. The energy then required for covering the 180 kilometres should be eighty-one by Artom's system, as compared with 169 by the older system—that is to say, about half is saved.—*Abstracted from the Electrical Magazine (London), June* 27.

Tests of Single-Phase Traction in Paris.

Recent tests have been made of a single-phase motor for traction purposes in Paris, France. The motors have been built by the French Thomson-Houston Company, after designs prepared by M. L. Gratz-Müller, and have been tested on a section of the Clozeaux road 1,600 metres in length. This section of road has been isolated, and by means of a motor-generator set is supplied with alternating single-phase current at 500 volts. The car is carried on a single truck with four wheels, and on the axles are mounted two fifty-horse-power, single-phase motors. The motors are designed on the Latour system, which is a combination of the single-phase compensated motor with a repulsion motor. There are four field poles and eight sets of brushes. Alternate brushes are short-circuited together through a resistance. The remaining four brushes carry the main current and connect the armature in series with the field winding. A compensated exciting coil is added to the field winding to reduce sparking. The repulsion principle is employed to increase the starting effort. The stator or field resembles the stator of an induction motor, while the armature is wound as if for a four-pole, direct-current machine. This arrangement of windings enables the motor to run sparklessly at all loads, and to start with little or no sparking. It also maintains the power-factor at nearly unity when running. The motors weigh 1,350 kilogrammes each. The frequency of the supply is twenty-five cycles, the pressure 300 volts. Speed regulation is obtained by means of a variable-voltage transformer. The primary of this is connected in series between the trolley wire and ground; the secondary is divided into six coils. The motors are connected permanently in parallel on the secondary circuit, with reversing switches interposed. The controller consists of a reversing switch of the drum type, and a regulating switch for varying the connections of the secondary of the transformer. This switch is a dial turning about a horizontal axis, being moved through bevel gears by a handle at the top of the controller. Contacts on this plate make connection between the jaws of switches supported from the controller, a system of springs interposed between the dial and the operating gear bringing about a quick movement. After testing the car empty it was loaded with four tons of cast iron, with which load it ran satisfactorily, starting and mounting grades without sparking. It was found from these experiments that the motors, which had been designed liberally, could be reduced considerably in size; that the air-gap, which was two millimetres, could be made larger if desirable, and that the transformer, which weighed 1,100 kilogrammes, could be made lighter. The motors run in either direction without sparking.—*Translated and abstracted from L'Éclairage Électrique (Paris), June* 24.

The National Electrical Contractors' Association.

Annual Convention Held in Boston, Mass., July 18-22, 1905.

[By telegraph to the Electrical Review.]

BOSTON, July 19—The annual meeting of the National Association of Electrical Contractors was formerly opened in the auditorium of the Mechanics' Hall, Boston, Mass., on Wednesday July 19, at 10.30 A. M.

On Tuesday at ten o'clock the directors of the National Association held a preliminary meeting.

At the opening session on Wednesday there were registered 287 members and guests.

Among the registered guests were:

R. B. Corey, American Circular Loom Company; Frank Booth, New York Wire Company; Charles J. Marsh, manager, Frank Clark Cosby and Clarence Weissblatt, Standard Underground Cable Company; H. B. Coho, Burke Electric Company; H. G. Issertell, Sprague Electric Company; J. B. Olsen, India Rubber and Gutta Percha Insulating Company; C. E. Corrigan, Osburn Flexible Conduit Company; C. T. Purdy, American Electric Lamp Company; A. F. Wilson, Marshall Electric Manufacturing Company; H. E. Lindsey, Peerless Electric Company; H. B. Oakman, Tray Plate Battery Company; F. M. Hawkins, Crouse-Hinds Company; R. A. Schoenberg, Sarco Company; Max Loewenthal, Prometheus Electric Company; D. F. Ivins, John A. Roebling's Sons Company; I. M. Post, Clifton Manufacturing Company; Charles P. Skinner and C. F. Moore, Electric Contract Company; William S. Brown, W. E. Phelps, president of the Phelps Company; Frank S. V. Sias, eastern representative of the National Conduit and Cable Company; H. S. Miller, secretary, and B. C. Kenyon, Diehl Manufacturing Company; H. L. Shippy, John A. Roebling's Sons Company; John Dale, the Dale Company; A. L. Deveau, Deveau Telephone Manufacturing Company.

Mr. F. L. Barnes, president of the Massachusetts Electrical Contractors' Association, delivered a brief address of welcome. He announced that the governor of the state could not be present and that Mayor Collins had unfortunately been compelled to be absent. The meeting was turned over to Ernest McCleary, president of the National Electrical Contractors' Association, who received volley after volley of applause from his friends and admirers.

President McCleary first called attention to the remarkable exhibition and congratulated the Massachusetts association upon its success. He commented upon the benefits derived from membership in the national organization, particularly with reference to the relations to the contractors and the National Board of Fire Underwriters. The association must flatly oppose, he said, ridiculous interpretation of the electrical code and must see to it that there was uniformity in the demands to be met in the different states. The electrical contractors were in a position to give good practical advice and could be of much service to the fire underwriters, now that a better understanding is coming about. He rehearsed the history of the association and paid a tribute to Charles L. Eidlitz, the first president, whose absence was a cause of regret. Concluding his address he stated that the purchasing power of the National Association was sixteen million dollars annually, exclusive of motors and generators. This power was one for good and must ever be used not to destroy, but to build up.

F. E. Cabot, of Boston, Mass., president of the electrical committee of the National Board of Fire Underwriters, addressed the meeting on the subject of "The Underwriters." The inspection of electrical installations was not a proper function of the underwriters. He said that they had been forced to it to safeguard the enormous interests they represented. The fire loss is over two hundred billion dollars annually, and it is to render the hazard as good as possible that rigid inspection of electrical installations was demanded. The possibilities of faulty work were enormous and it was necessary to enforce the code even in its minor details.

Mr. Theodore Beran, of the General Electric Company, delivered an address, entitled "The Manufacturer." He emphasized the necessity of cordial relations between the manufacturer and the contractor and said that each should stand ready to assist the other when the occassion demanded it. Mr. G. M. Stuart, of the Stuart-Howland Company, Boston, Mass., delivered an address on "The Jobber." The electrical industry, which now ranked first among industries, had helped in some way every individual. Those engaged in this industry might justly feel proud. For the best interest of all concerned, the freest intercourse of trade should be carried on. The past seven years had witnessed a remarkable change in the sentiments of competitors, and the affiliation of the jobber and contractor was a step in the right direction.

"The Relation between the Electrical Contractor and the City of Boston" was the subject of a brief address by J. A. Cole, chief inspector of the inspection department of the city of Boston. Prior to 1890 when the state legislature passed the proper laws there was no legal inspection in the state of Massachusetts. Notwithstanding the good work of the inspection department of the Fire Underwriters, there were some points which must be under state supervision. The contractor and the inspector met on common grounds. Where each did his best there would be little chance for ill will or imposition. It was to this end that the association should direct its effort.

Mr. T. Carpenter Smith was called upon and he delivered a very witty address upon the "Tribulations of the Contractor."

After adjournment the credential committee held its session.

Wednesday morning the ladies made a long trolley trip, visiting Brookline, Auburndale, Waltham, Lexington, Bedford and Concord.

The annual dinner was held at the Hotel Brunswick on Wednesday evening, and on Thursday a special outing was held at Nantasket Beach.

The election of officers will take place on Friday.

On Friday a trip was arranged for the ladies on an observation tour about Boston and its environs. The balance of the time was devoted to executive sessions.

Upon the request of Mr. C. J. H. Woodbury, the American Telephone and Telegraph Company gave the members of the association complimentary service over its local and toll lines during the convention.

Colorado Electric Light, Power and Railway Association.

The Colorado Electric Light, Power and Railway Association will hold its third annual convention at Glenwood Springs, Col., September 18, 19, and 20, 1905. Mr. George B. Tripp, Colorado Springs, Col., is the secretary of the association.

The International Electrical Exhibition.

A Very Successful Electrical Show Held in Boston, Mass., July 15-22.

ON SATURDAY evening, July 15, at eight o'clock, the immense floor space of the Mechanics' Hall, Boston, Mass., was filled to overflowing with an enthusiastic and interested throng of visitors to the opening of the International Electrical Exhibition, held under the auspices of the National Electrical Contractors' Association of the United States and the Massachusetts Electrical Contractors' Association. That the exhibition was a pronounced success was evident from the moment the doors were thrown open. It is estimated that between 25,000 and 30,000 people passed through the gates.

The local committee deserve great credit for bringing their plans to so successful a culmination. Pingree's Boston Band rendered daily musical concerts and every effort was made to make the occasion a most happy and interesting one.

While a number of exhibitors were distinctly local to Boston and its environs, there were so many manufacturers from states other than Massachusetts that the show was truly national in its representation. Aside from the regular line of electrical apparatus of every description, a number of spectacular features were provided which added greatly to the enjoyment of the hosts present. The high-frequency apparatus of the Ovington Manufacturing Company was the centre of attraction along with the giant X-ray machine exhibited by the Heinze Electric Company. The electrical heating and cooking apparatus shown by the Simplex Electrical Company and the Prometheus Electric Company and the high-frequency sign of the Westinghouse Electric and Manufacturing Company also attracted a great deal of attention. Mr. C. S. Knowles had secured the mammoth 200,000-volt transformer built at the Worcester Polytechnic Institute, and with this apparatus were given some remarkable displays.

The immense hall was beautifully decorated with bunting and flags, and these, along with palms and potted plants interspersed in every direction with incandescent, Nernst and Cooper Hewitt lamps, made it a scene which was at once bewildering and entrancing. Through the courtesy of the American Mutoscope and Biograph Company and the Westinghouse Electric and Manufacturing Company six shows each day were given of a trip through the Westinghouse works. These views were highly interesting, and a number of them were decidedly funny. The attendance at each of these shows taxed the exhibition space to its utmost.

There were a number of decidedly novel exhibits—the joint display of the Perkins Electric Switch Manufacturing Company and the Bryant Electric Company, the General Electric Company's exhibit, the remarkable display of the American Circular Loom Company, the Westinghouse exhibit occupying all of the large platform space, and the pergola of the John A. Roebling's Sons Company, all exciting commendation from the visitors.

There were in all some eighty manufacturers who made exhibits that were more or less elaborate. Among these were the following:

Alphaduct Manufacturing Company, New York city. Alphaduct and flexible conduit. Represented by Russel Dart, Jr.

The American Electric Novelty and Manufacturing Company, New York city. Dry batteries, miniature and decorative lamps, electric clocks, portable electric lamps, "Noscru" push-buttons, "Sarco" specialties. Represented by F. J. Colvin, S. S. Shepard and William G. Mills.

American Circular Loom Company, Chelsea, Mass. "Circular Loom," "Electroduct" and "Lutz" metal moulding. Represented by A. T. Clark, Oscar Hoppe, H. B. Kirkland, Thomas H. Bibber, R. B. Corey, H. Adams and M. F. King.

American Electric Sign Company, Boston, Mass. Electric signs of various types, a changeable electric mirror sign, and other sign and decorative features. Represented by C. Inglis Wetmore, manager; J. L. Russell and Charles Borden.

Benjamin Electric Manufacturing Company, New York and Chicago. Wireless clusters, electrical specialties, new series clusters, new twin socket with mirror reflector, "Daylight" and "Arc-Burst" clusters, weatherproof fixtures for high voltages. Represented by Basil J. Kodgbanoff.

Blake Electric Company, Boston, Mass. Repair work on switchboards, dynamos and motors. Represented by F. R. Blake, H. A. Queen and G. R. Ambleman.

Booth & Company, Boston, Mass. "Climax" stock guard, "Kant-Leak" valve, "Universal" pipe and "Szerelmey" stone liquid. Represented by H. E. Cowan.

Bossert Electric Construction Company, Utica, N. Y. Panel-boards, outlet boxes, outlet bushings, cabinets and knife switches. This company's booth was elaborately decorated, and attracted a great deal of attention. Represented by F. G. Scofield, F. T. Foxenberger, F. B. Smith, W. P. Crockett and R. B. Corey.

Bryant Electric Company and the Perkins Electric Switch Manufacturing Company, Bridgeport, Ct. A full line of Bryant and Perkins specialties, push-button switches, panel switches, Bryant enclosed fuses. Represented by Victor C. Gilpin, W. C. Bryant, E. R. Grier, Edward Patton and J. E. Way.

Chase-Shawmut Company, Newburyport, Mass. Panel-boards, National Electric Code fuses, cutouts, junction boxes, Chase nipples and couplings, Shawmut rail bonds, Shawmut bushings and check nuts, and Shawmut open fuse links. Represented by H. P. Moore, F. S. Masterson and J. J. Wiley.

Condit Electrical Manufacturing Company, Boston, Mass. Circuit-breakers and switchboards. Represented by S. B. Condit, Jr., P. R. Fisher, F. W. Nason. These gentlemen also represented S. B. Condit, Jr., & Company, exhibiting the "Atlas" hangers and "T. & B." outlet boxes, bushings and locknuts; and the Safety Armorite Conduit Company, exhibiting "Loricated" and "Galvaduct" conduits.

Cooley General Development Company, Jamaica Plain, Mass. Direct-connected electric generator set, belted engines, reversible automobile and yacht engines, direct-connected centrifugal pumping set, direct-connected blower and fan set. Represented by J. F. Cooley and W. F. Hanaford.

Cooley Manufacturing Company, Waterbury, Vt. Cooley marine gasoline motors. Represented by Frederick Cooley.

R. M. Cornwell Company, Syracuse, N. Y. Gasoline engines, Cornwell universal switch box, "Wonder" dynamos and motors. Represented by R. M. Cornwell and F. S. Baldwin.

S. H. Couch Company, Incorporated, Boston, Mass. This company made a very beautiful display, on revolving stands, of intercommunicating telephones, automatic

telephones, switchboards, magneto call instruments, portable desk instruments, flush telephone instruments, exchange apparatus, spiral lamp guards, and a complete line of telephone accessories. Represented by S. H. Couch, C. E. Monroe, William Couch and Frank Whitman.

Couch & Seeley Company, Boston, Mass. A full line of interior intercommunicating telephones, exchange telephones, both central energy and magneto; switchboards and hotel annunciator systems; an all-iron complete street railway box—a good deal of the apparatus being connected up and shown in operation. Represented by F. C. Redfield, R. L. Whitman, A. R. Calder, E. B. Seeley and C. G. Fisher.

The Cutter Company, Philadelphia, Pa. Sample board of I. T. E. circuit-breakers. Represented by W. C. Jessup.

The Dale Company, New York city. A line of wireless clusters, shades and special fixtures. It is unfortunate that the fire of July 7 made such inroads into the company's beautiful stock that it had been preparing for exhibition that it could not make the elaborate display it had contemplated. The material that was shown, however, attracted a great deal of attention, and was a valuable index of what might have been accomplished but for the fire. Represented by O. J. Bryan and H. S. Rainsford.

Deveau Telephone Manufacturing Company, New York. Represented by A. L. Deveau.

Dossert & Company, New York city. Solderless wire and cable connectors. Represented by H. A. Bristol and M. R. Jarvis.

Dunton & Field, Cambridge, Mass. The Dunton tree insulator. Represented by C. H. Dunton and F. D. Field.

D & W Fuse Company, Providence, R. I. Fuses and fuse boxes, switch blocks, subway boxes, "Deltabeston" wire, railway field coils insulated by "Deltabeston" methods. Demonstrations were given showing wire heated red hot, and failing to char the "Deltabeston" covering. Double cotton-covered wire was placed in series with the regular "Deltabeston" wire, and current sent through until the cotton wire charred, without affecting the "Deltabeston" insulation. Represented by L. W. Downs, manager; W. S. Sisson, secretary, and C. E. Harmon.

Duren & Kendall, Boston, Mass., acted as New England agents for the Calculagraph Company and the Fisher Book Typewriter Company, both of New York city.

Eastern Carbon Works, Jersey City, N. J. Dry batteries, battery connectors, carbon brushes, carbon plates, carbon cylinders and carbon specialties. There were a number of dry batteries connected up to battery fan motors, showing the life and utility of these dry batteries. Represented by G. W. Mills, William Mills and Mr. Turgeon.

Economical Electric Lamp Company, New York city. "Economical" lamps. Represented by W. F. Abely and William Murphy.

Electric Gas Lighting Company, Boston, Mass. Telephones, annunciators, electric gas lighting apparatus, Samson batteries, electrical house-wiring goods. Represented by H. S. Thomson, C. E. Lee, C. H. Young, C. F. Howes, F. R. Sherman, Carl Norris and A. F. Boardman.

Electro-Dynamic Company, Bayonne, N. J. A four-to-one speed range "Interpole" motor belted to a generator. This apparatus was supplemented by amperemeters and voltmeters showing the performance of the "Interpole" motor. In addition to this there were details of the apparatus showing the field frame and armature construction and the ball bearings. Represented by G. Herbert Condict, F. S. Mitchell, F. G. Bell and G. Warner.

Peter Forg, Somerville, Mass. Adjustable electric light fixtures. Represented by Peter Forg and Charles I. Pierce.

Charles Garrison, Trenton, N. J. De Laval steam turbine.

The General Electric Company, Schenectady, N. Y. The new metallized carbon filament incandescent lamp. Three sizes were shown, taking 125, 187.5 and 250 watts respectively. The company's large space was illuminated with these lamps, which were fitted with two styles of Holophane reflectors. A thirty-ampere mercury-arc rectifier operating on a 220-volt single-phase circuit and delivering 110 volts direct current. A collection of small motors, alternating and direct current, including standard fan motors and one of the new automobile motors. A new electric flat-iron. A feature of this exhibit was the moving picture machines, which showed the race between an electric and a steam locomotive and the employés leaving the Schenectady works. A comfortable reception space was arranged at each end of the exhibit. Represented by C. B. Davis, J. P. Felton, O. F. Brastow, L. E. Smith, J. A. Wilson, E. M. Kinney, W. M. Wright, and F. H. Gale.

G. M. Gest, New York city. A fine exhibit of photographs of work done in different cities of the United States, Canada and Mexico. These photographs are particularly handsome, and attracted a great deal of attention. Represented by W. T. Jackson, Cincinnati (Ohio), agent.

Gilmore Electric Company, South Boston, Mass. Represented by William Gilmore.

Gray National Telautograph Company, New York. The Gray telautograph. Represented by Henry Keep.

Heinze Electric Company, Lowell, Mass. X-ray and wireless telegraph apparatus.

Harvey Hubbell, Bridgeport, Ct. New wireless porcelain clusters, standard and multiple attachment plugs, standard pull clusters and brackets, a full line of sockets and receptacles, standard pull sockets, pull candelabra sockets, wall switches, new parabola shades and reflectors. Represented by H. W. Bliven, sales manager, and Edward Mora.

W. S. Hill Electric Company, New Bedford, Mass. Tablet boards, a 6,000-ampere switch, field-discharge motor and standard switches, brass and oak cabinets. Represented by C. S. and F. A. Knowles.

Holophone Glass Company, New York city. A full line of Holophane glass and pagoda reflectors, new designs and combinations. Represented by S. W. Farquharson, H. C. Jones and J. S. Codman.

Jamaica Plain Electric Company, Jamaica Plain, Mass. Gleason moulding boxes and junction boxes. Represented by John L. Gleason and R. Eberhardt.

H. W. Johns-Manville Company, New York city, and the Johns-Pratt Company. "Noark" and National Electric Code standard fuses, fuse blocks, "Electrobestos" conduit, asbestos, "Transite," railway line material and fire extinguishers. Represented by J. W. Perry, A. D. Newton, J. Humphreys, E. B. Hatch and Joseph Sachs.

Johnson & Morton, Utica, N. Y. The new style "BD" distributing cabinet and the "Universal" direct-connection panel. The first-mentioned apparatus is so arranged that the box can be drilled for outlets right on the job, and can be connected up before the tablet is placed. The entire box is self-contained. The "Universal" direct-connection panel is arranged for a combination box of two or three-wire mains, enclosed fuses, link fuses or plug fuses, with and without knife switches. This makes it possible to carry a small stock, and still be prepared for any ordinary contracting demand. Represented by M. H. Johnson, W. H. Morton and J. H. Cramphorn.

Improved Moulding Company, Phila-

delphia, Pa. Represented by W. T. McDowell.

C. S. Knowles, Boston, Mass. High-tension insulators, braces and materials, steel pins, "Enamelduct" conduit, a 300,000-volt testing transformer. Represented by J. A. Sanford, Jr., Geo. A. Ober, H. M. Saben, A. D. Richmond, Duncan Kennedy and W. O. Turner.

Manhattan Electrical Supply Company, New York city. Represented by J. W. McDowell.

Marshall Electric Manufacturing Company, Boston, Mass. A full line of sockets and switches. This exhibit showed some of the newest productions in electrical fittings made possible with moderate automatic machinery. The company was represented by Norman Marshall and V. G. Eastman.

McKenney & Waterbury, Boston, Mass. An elaborate line of chandelier, candelabra, desk and reflector lamps and fixtures. Miniature lamps. Represented by W. A. McKenney, F. S. Waterbury, C. W. Martin, R. J. Green, N. J. Allen, Jr., F. W. Patten, G. F. Fuller, J. J. Tobin, F. F. Martin, C. A. Cline, A. E. Phelps, H. Van Buskirk, J. H. Frates and Herbert White.

August Meitz Iron Foundry and Machine Works, New York. A six-horse-power engine and generator. Represented by F. E. Davis.

National Carbon Company, Cleveland, Ohio. Batteries of every description, arc light carbons, carbon for electrical furnaces, carbon brushes, and carbon material for telegraph instruments, flash-lights and other uses. Represented by J. C. Irvine.

Olds Gasoline Engine Works, Lansing, Mich. Olds stationary and portable engines. Represented by N. E. Shepherd, Frank Gaplin and E. T. Harwood.

Osburn Flexible Conduit Company, New York city. "Flexduct." Represented by C. E. Corrigan and W. P. Ambos.

H. T. Paiste Company, Philadelphia, Pa. H. T. Paiste specialties, cutouts, branch blocks, fuse blocks, panel boxes, panel cutouts, entrance switches, angle sockets, pendant sockets, and a new method of hanging weatherproof sockets and "Holoshade" sockets. "Aleck, the electrician," was a popular representative and met many old friends. Represented by George MacElwee, Charles I. Hills and E. A. Jenkins.

Pass & Seymour, Solvay, N. Y. Pass & Seymour material of every description, particularly a full line of brass shell sockets and receptacles. Represented by W. Brewster Hall, A. M. Little, John W. Brooks and B. E. Salisbury.

Pettingell-Andrews Company, Boston, Mass. A full line of electrical specialties of various descriptions. This company had two separate booths, showing in one electrical glassware, and in the other the various electrical merchandise for which the company is distributing agent. Represented by W. J. Keenan, sales manager; F. W. Cramphorn, R. W. Vose, W. A. Pieterson, H. H. Van Staange and M. T. Palmer.

Prometheus Electric Company, New York city. A line of electric heating and cooking apparatus. Represented by Max Loewenthal, electrical engineer, and Herbert W. Smith.

Ridgway Dynamo and Engine Company, Ridgway, Pa. Thompson-Ryan dynamos, McEwen engines, Thompson-Ryan variable-speed motors. Represented by James L. Kimball, G. L. Fitz and B. D. Delano.

John A. Roebling's Sons Company, New York city. Copper wire and wire of all descriptions. Represented by H. L. Shippy, Frank W. Harrington, S. B. Van Nortwick and Albert Mann.

Renim Specialty Company, Brighton, Mass. A full line of Renim switch and outlet boxes, cutout cabinets and trims, and the "Ideal" floor tread. Represented by Miner Robinson, manager.

Shelby Electric Company, Shelby, Ohio. This company had its booth attractively fixed up so that there could be a visual comparison of the vertical illuminating intensity of the Shelby and other types of incandescent lamps. The booth was also equipped with a complete set of testing instruments, an angulator being attached to the photometer, so that the luminous intensity could be measured instantly in every direction. Represented by C. W. Cartwright, Boston, manager.

Simplex Electric Heating Company, Cambridge, Mass. A full line of electric heating and cooking apparatus. Represented by C. W. Richards.

Sprague Electric Company, New York city. Lundell fan motors, Lundell power motors and generators, Sprague electric hoists, Greenfield flexible conduits, and steel-armored hose and conductors; also new brass-armored flexible conductors for vessels and underground service. Represented by Alexander Henderson, H. H. Hornsby and H. C. Farnesworth.

Standard Underground Cable Company, Pittsburg. Represented by F. C. Cosby and C. Weissblatt.

Steel City Electric Company, Pittsburg, Pa. Represented by J. M. G. Fellman.

Stuart-Howland Company, Boston, Mass. Stuart-Howland street fixtures, George Cutter Company's specialties, Garton-Daniels lightning arresters, Edison dry batteries, Sterling lamps, "Wizard" igniters and spark plugs, Hart switches, electric portables, Helios-Upton arc lamps, Splitdorf coils, Franklin clusters, Russell-Tomlinson interior telephones, Abbott time switches, Varley coils, Wotton loud-ringing extension bell, Thompson automobile switches, Atwater-Kent measuring instruments, Adams secondary generator, and Henricks magneto. Represented by A. E. Payne, C. B. Wetmore, R. M. Merritt, J. Briton Bailey, J. T. Hessell, G. M. Stuart, A. Howland, J. E. Wilson, H. De Steese, C. R. Fish and H. L. Dalton.

Herbert W. Smith and the Charles A. Thompson Company had a joint exhibit representing a number of companies, as follows: Chicago Mica Company, Valparaiso, Ind., manufacturer of mica in different forms; Teter-Heany Developing Company, York, Pa., fireproof wire; Rhode Island Electric Works, Pawtucket, R. I., cotton and silk-covered double and single magnet wire, German silver resistance wire; Swazey & Smith, Boston, Mass., high and low-tension brackets for street railways, corrugated trolley poles, pure copper trolley wheels, and self-lubricating trolley wheel axles; Waterbury Company, New York, wire rope, manila rope, lead-covered cables, switches and panel-boards, and rubber-covered wire; Thompson-Bonney Company, New York, revolving showcase; Insulating Company, New York, insulating cement; Thompson Company, New York, a general line of supplies. The Charles A. Thompson Company was also represented by Mr. Rudolph Miehling.

Trumbull Electric Manufacturing Company, Plainville, Ct. Knife switches, plug cutouts, panel cutouts, rosettes, receptacles, iron fuse boxes, pendant switches, combination switches, weatherproof sockets, porcelain base switches, flush receptacles, cord adjusters, panel-boards and fuse blocks. This material was all adjusted on open panels. Represented by J. H. Trumbull, Henry Trumbull, Frank Trumbull, G. W. Edge, Frank T. Wheeler and C. W. Jones.

Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. High-potential static sign and induction-motor-driven cotton loom, direct-driven without interposition of friction clutch. An archway of incandescent lamps, and a com-

plete line of arc lamps, measuring instruments; also an attractive display of three-glower Nernst lamps and Cooper Hewitt mercury vapor lamps. Represented by J. C. McQuiston, C. B. Humphrey, G. B. Griffin, D. E. Manson, R. L. Warner, M. H. Merrill, L. M. Reed, L. Watts, C. L. Abbott, George Wahn, Charles Wahn, and Messrs. Owen, Walton, Young, Gibbs and Bates.

O. C. White Company, Worcester, Mass. New strap-clamp lamp fixture for wall, ceiling, desk or machine-shop service, and a special fixture for drafting tables. Represented by Frank M. Pond and O. C. White, Jr.

Wireless Railway Company, Philadelphia, Pa. A working exhibit of the Pullen wireless railway surface-contact system. The surface-contact plugs are placed between the tracks, and contact is made by lifting an armature in the box by an electromagnet carried on the car. This armature makes contact with a number of flexible copper studs, and a shoe carried by the car rubs and takes current from the manganese steel block set in the box. The system works entirely by electromagnetic attraction and gravity. There were also a number of views of the Pullen system, and the Pullen wireless battery was displayed. Represented by Leon W. Pullen, president; George F. Bradstreet; Charles E. Kelley; J. Bernier, electrician, and Arthur P. Hosford.

Worcester Electric Manufacturing Company, Worcester, Mass. Knife switches, switchboards, panel-boards, cabinets, front and back-connected switches, single-break, double-break and combination switches. Represented by Joseph P. McGrady and John McGrady.

Yale & Towne Manufacturing Company, New York. Electric hoists, triplex, duplex and differential chain blocks, overhead trolleys. This exhibit attracted a great deal of attention, and demonstrations were made showing the application of the new electric hoist and the various types of chain blocks. Represented by C. W. Beaver, William Hazelton and John T. Boyd.

Electrically Operated Water-Tight Doors.

Among the few American inventions which are on display at the Naval, Shipping and Fisheries Exhibition at Earl's Court, London, this summer, a full-size working exhibit of the "Long Arm System" of electrically operated water-tight power doors has attracted great attention from the large number of naval experts who have visited the display. This system, from a central station located at a convenient point on the bridge of the ship, closes the doors and hatches of the vessel in time of emergency, providing for the local safety of men involved by a liberty action attached to each door. The device has now been installed on some thirty American men-of-war, and the admiralty departments of numerous foreign governments are interesting themselves in the system with a view to placing it on all their own ships. In addition to the exhibit at Earl's Court, there is another full-size working exhibit on display at 39 Victoria street, London.

An Unbroken Chain of Submarine Cables.

About twenty years ago, according to the *British Trade Review* (London), it was proposed to construct a system of submarine telegraph cables connecting all parts of the British Empire. For various reasons the project was not pushed, but cables have been laid from time to time, so that at the present day about one-third of the system proposed then has been completed. The last to be laid was the Pacific cable from Vancouver, on the western coast of Canada, to Australia and New Zealand. To complete the system the following cables are needed: from the United Kingdom to Vancouver and the Pacific, a new cable across the Atlantic and land lines through Canada; from Australia across the Indian ocean to South Africa, with a branch from Cocos Island to India; from Cape Town to England by way of Ascension, the West Indies and Bermuda, with a branch to Canada. This project is now being considered at a cable conference which has been sitting at the British Colonial Office. The various parts of the empire are represented.

The Cost of Farming with an Automobile.

A special type of automobile has been brought out recently by the Scott Motor Cultivator, Limited, Edinburgh, Scotland, which is adapted to all classes of farm work. The motor may be equipped with a reaper or with a cultivating device which prepares the ground and sows the seed in one operation. When not in use in the field it may be employed for driving all farm machinery. This motor, traveling at the ordinary pace of a horse drawing a plow, gives complete and final cultivation to six or seven acres a day. Assuming this machine to be used for only 250 days per year the cost for a day's work, including interest, depreciation, fuel and labor, is said to be $6, or $1 per acre, less than half the cost of plowing by horse. The machine costs about $1,500.

First Long Island Railroad Electric Train.

The first electric train to be run on Atlantic avenue, Brooklyn, N. Y., by the third-rail system started from the Manhattan crossing shortly after eleven o'clock on Tuesday, July 18, with a party of Long Island Railroad officials on board. The train consisted of two new fireproof motor cars and was followed by a locomotive, in case there was a breakdown.

The train, after reaching Flatbush avenue, was started again for Rockaway Beach, running over the entire division, which has only recently been equipped with the third rail. The trip was made without a mishap.

A Safety Device for Telephone Lines.

A device which is thought to overcome the disadvantages of the heating coil used to protect telephone apparatus has been invented by M. Van Deth, and is described in *L'Industrie Electrique* (Paris), June 25. The apparatus consists of a small electromagnet of a plunger form, which is connected in series with the line. When an excessive current passes through the line the magnet lifts the plunger, striking a detent, and thus releasing the spring of a contact, which opens the circuit. The plunger then returns to its original position, and a pressure of the finger on a projecting knob resets the device. The advantages of this over the heating coil are the smaller resistance, the instantaneous opening of the circuit, the easy resetting of the device, and the inductance of the coil, which assists the lightning arrester in its operation.

Conventions of Street Railway Associations.

The ninth annual convention of the Street Railway Accountants' Association of America will be held in Philadelphia, Pa., September 28, 29 and 30. The headquarters of the association will be at the Hotel Walton.

The Mechanical and Claim Agents' Associations will meet on Monday and Tuesday, September 25 and 26.

The American Street Railway Association will meet on Wednesday and Thursday, September 27 and 28.

The annual convention of the American Street Railway Association will be held in Philadelphia, Pa., September 25-30. The south pavilion of the Philadelphia museums and an ajoining building will be used for exhibition purposes. The Pennsylvania Railroad has a switch track which enters the buildings, and there is some 500 feet of track under cover. Outside of the buildings there is also a considerable portion of space for outdoor exhibits, and two railroad tracks. It is understood that arrangements can be made for the purchase of all necessary electric power.

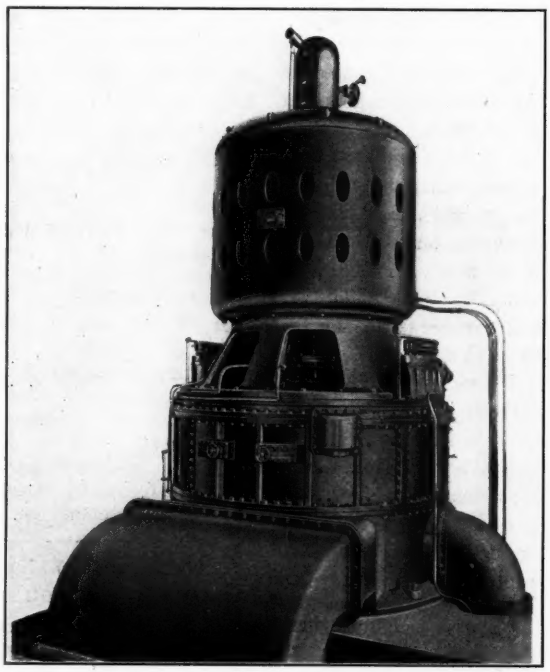
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Steam Turbine Performance.

A test has been made recently by Messrs. Louis A. Ferguson, of the Commonwealth Electric Company, Chicago, Ill., and Frank Sargent, of Sargent & Lundy, also of Chicago, of a 2,000-kilowatt Curtis turbine. In connection with this test Mr. W. L. R. Emmet says:

"The machine is of the four-stage type, designed in 1903, and recently changed in a few particulars as a result of experiments during the past year. The machine tested conforms as nearly as possible to the standard four-stage machines now being produced. It is less efficient, since the changes made have been confined to the buckets, while the several other important changes known to be desirable could not be made in this case without entirely rebuilding the machine."



2,000-KILOWATT CURTIS STEAM TURBINE.

The results reported have been determined by the most accurate methods, and have been verified by repeated tests in addition to those conducted by Messrs. Ferguson and Sargent. Before the test was made assistants were sent to Schenectady to prepare the apparatus for the work. Several preliminary trials were made, the results of which agreed well, indicating that conditions were good. All the instruments used were carefully tested and standardized during the trials. The electrical instruments were tested by the Electrical Testing Laboratories, and no precaution that could be observed was neglected. The following are the results obtained:

FULL-LOAD TEST.

Duration of test	1.25	hours
Steam pressure (gauge)	166.3	lbs.
Back pressure (absolute)	1.49	inc. of mercury
Superheat	207.0	deg. F
Load in kilowatts	2023.7	
Steam consumption per kilowatt hour	15.02	lbs.

HALF-LOAD TEST.

Duration of test	0.916	hour
Steam pressure (gauge)	170.2	lbs.
Back pressure (absolute)	1.40	inc. of mercury
Superheat	120.0	deg. F.
Load in kilowatts	1066.7	
Steam consumption per kilowatt-hour	16.31	lbs.

QUARTER-LOAD TEST.

Duration of test	1.0	hour
Steam pressure (gauge)	155.5	lbs.
Back pressure (absolute)	1.45	inc. of mercury
Superheat	204.0	deg. F.
Load in kilowatts	555.0	
Steam consumption per kilowatt-hour	18.09	

ZERO LOAD.

Duration of test	1.33	hours
Steam pressure	154.5	lbs.
Back pressure (absolute)	1.85	inc. of mercury
Superheat	156.0	deg. F.
Steam consumption per hour	1510.5	lbs.

"Peru" Tie Buttons.

One of the National Code standard specialties recently developed by the Peru Electric Manufacturing Company, Peru, Ind., is the "Peru" tie button, several forms of which are illustrated herewith.

Fig. 1 shows the "Peru" cleat tie button, which is in reality a cleat and tie button combined. There is a cavity in the cap which accommodates a knot in the cord, relieving the main wires from all strain. The manufacturer emphasizes this feature of simplicity as a cleat, two screws and about half the time in wiring are saved for every "Peru" tie button so installed.

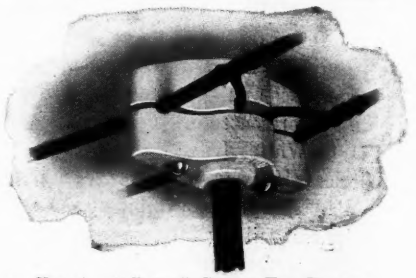


FIG. 1.—"PERU" CLEAT TIE BUTTON.

Fig. 2 and Fig. 3 show, respectively, the concealed and moulding designs of this tie button. The illustrations are self-explanatory, and show at a glance the features of value embodied in these specialties. A peculiar feature of these tie buttons is found in the washer collar that surrounds the screws and keeps them from falling out of the cap.

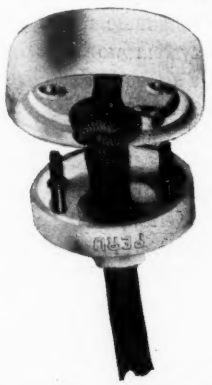


FIG. 2.—CONCEALED TYPE "PERU" TIE BUTTON.

These tie buttons are designed for use when soldering the lamp cord to the main wires. No terminals are exposed, and they are particularly substantial devices for wiring factories, cellars and all damp places.

FIG. 3.—MOULDING TYPE "PERU" TIE BUTTON.

New Type Radial Arm Crane Controllers.

The illustrations herewith show a new type of crane controller, known as the radial arm, which is being placed upon the market by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. In designing these controllers the purpose was to overcome the difficulties met with in former types and to attain, with the most simple construction possible, proper control with the minimum number of points at which arcing could occur as the controller deteriorated in service, and to make certain that when arcing did occur it would be under predetermined conditions and with ample protection. In addition, provision was made for ease of operation, adaptability to all conditions of service, ease of renewals and interchangeability of parts.

TYPE "A"—RADIAL ARM CRANE CONTROLLER.

In types B and C these ends were achieved by mounting the front above the resistance, thus giving free accessibility to the connections on the back of the slate. The front itself consists of four sets of segments, the connections of which are so arranged that no reversing sector is necessary. The resistance is also arranged in four sections, each connected to its respective set of segments, making the wiring simple, and eliminating all crowding.

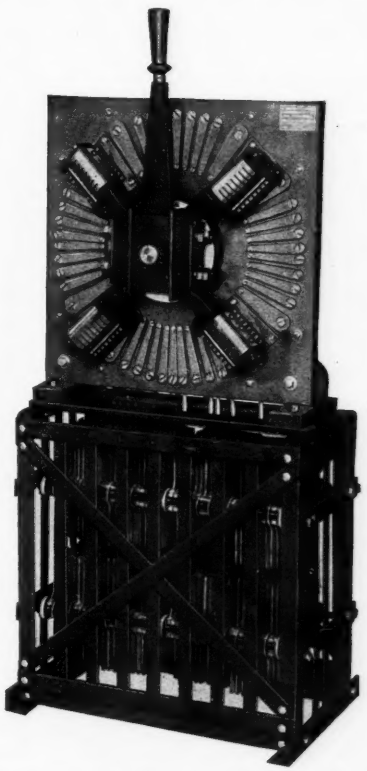
The lever is in three pieces, insulated from each other by large pieces of insulating material sufficiently massive to withstand any mechanical strain to which they may be subjected in use. Before being separated this lever is cast in one piece, and all work on it is done with jigs, which ensures positive interchangeability.

The blow-out consists of a coil surrounding and embracing the controller shaft on the front of the controller, and the iron of the framework is so disposed as to complete the magnetic circuit and give a powerful blow-out action at each of the four points at which the circuit is broken. The provision of a multiple protected break for the circuit reduces destructive arcing to a minimum.

A reliable centre indicating device is provided at the "off" position, which enables the operator to feel the central or "off" position, but which will in no way prevent his reversing quickly.

The type A controller differs from the above only in the mounting of the resistance, which is of iron enclosed-tube porcelain-insulated construction, and is carried directly by the front.

The type A controller and resistance may, therefore, be removed from the enclosing case and mounted directly in a recess provided, should this be desirable, as is frequently the case, in applying it to small trolley hoist work, etc.; or it may be rotated within the case so as to permit it being placed in any desired position, as on the sides or top of crane cab. It may also be arranged for rope operation from the floor, in which case a centering spring is provided.



TYPE "B" AND "C"—RADIAL ARM CRANE CONTROLLER.

Types B, C and D may be provided with bell crank and link to permit of installation at the back of the cab by levers at the front.

Resistance is provided which will give a speed reduction of fifty per cent under the average load conditions on the crane.

All contacts are of hard-drawn copper, and may be readily renewed from the front of the controller without disturbing any connections at the rear. All brushes are of drop-forged copper, easily renewable and interchangeable and are so shaped as to ride over the contacts and give a good working contact even when the contacts have become considerably roughened.

A large number of contacts is used, providing for gradual speed changes, and practically eliminating all sparking between segments.

The controllers are designed to occupy the minimum space consistent with the duty they are required to perform, and their arrangement is such that the operator's view is practically unobstructed.

Arrangements for slow-speed control may be obtained in types B and C. This feature has not been fully developed as yet, but description will shortly be given covering this feature.

A New Electric Car Brake.

A new form of electromechanical brake has been invented by Mr. McCullom, Toronto, Ont., and tested recently on the Weston line of the Toronto Suburban Street Railway. The brake consists of a specially built motor hung under the car, the armature of which is geared to a parallel shaft, to which is attached the chain that winds up the shoes to the wheel. A separate controller is used to manipulate the motor. A small band wheel is keyed to the chain shaft, and this operates to hold the brake shoes tightly on any grade. This band is released to release the shoes by touching a button on the motorman's platform. The brake can be applied gradually or put on with a shock in case of emergency. The operation is efficient with the pole on or off the trolley wire.

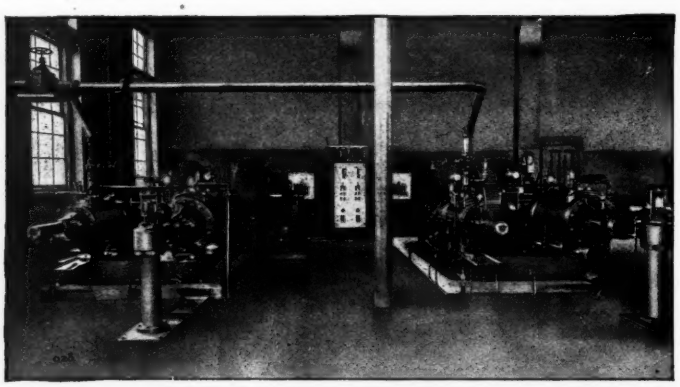
Crocker-Wheeler Company Election.

The officers of the Crocker-Wheeler Company, Ampere, N. J., have been re-elected for the ensuing year. The regular quarterly dividend of one and one-half per cent has also been declared, and the affairs of the company are stated to be in a flourishing condition.

The officers are: Schuyler Skaats Wheeler, president; Gano S. Dunn, vice-president and chief engineer; W. L. Brownell, treasurer; G. W. Bower, assistant treasurer. The directors are Francis B. Crocker, S. S. Wheeler, Messrs. Dunn, Doremus, A. Foster Higgins, Herbert Noble, Thomas Ewing, Jr., F. L. Eldridge and C. A. Spofford.

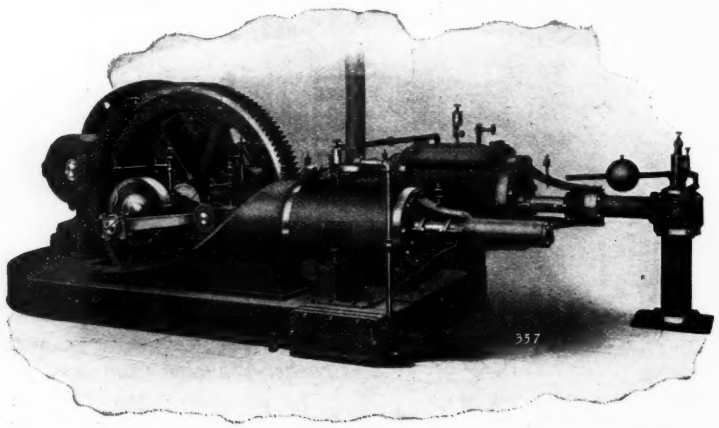
The Electrical Compressor Plant of the Chicago & Northwestern Railway Terminal, Chicago, Ill.

The air power plant at the terminal station of the Chicago & Northwestern Railway, in Chicago, is a fine example of modern practice in the application of electric power to the compression of air for the many purposes so characteristic of railway yard work.



AIR POWER PLANT AT TERMINAL STATION OF CHICAGO & NORTHWESTERN RAILWAY, CHICAGO, ILL.

The plant is located in a small brick building in the rear of the main terminal station, close to the river, and adjacent to the extensive passenger yards of the company. This building comprises two rooms, in one of which are the steam boilers for the heating system of the station. In the other section is located the electrical and pneumatic apparatus.



MOTOR-DRIVEN AIR-COMPRESSOR, AIR POWER PLANT AT TERMINAL STATION, CHICAGO & NORTHWESTERN RAILWAY, CHICAGO, ILL.

Alternating current is taken from the city mains of the Chicago Edison Company and passed through transformers reducing it to the working voltage. Part of it is used directly on low-voltage alternating circuits. The remainder is passed through rotary converters or motor-generators and delivered as direct current for power purposes.

The air-compressor plant is made up of two Ingersoll-Sergeant standard power-driven compressors, of the type designated by the maker as class "JC." They are duplex two-stage machines, with air cylinders, frames, and bearings mounted on a solid cast-iron bed-plate which encloses the horizontal inter-cooler between the cylinders. Both high and low-pressure cylinders are fitted with the standard Ingersoll-Sergeant piston inlet valve and regulation is secured by the maker's standard choking controller on the low-pressure intake. This device, acting to throttle the air intake passage, is controlled by receiver pressure and automatically regulates the volume of air compressed and consequently the amount of power consumed—to the demand for air from the power system. The compressors run at constant speed, the controller simply varying the effective piston displacement with varying load. The machines have a stroke of twelve inches, with air cylinders twelve and one-quarter and eighteen and one-quarter inches in diameter. At their speed of 130 revolutions per minute the free air capacity of each unit is 455 cubic feet per minute. The pressure used in this plant is seventy to eighty pounds gauge.

The subbase is extended in each compressor to support the driving motors, which are General Electric direct-current machines, rated at eighty horse-power and 510 revolutions per minute, 220 volts. A pinion on the motor shaft gears directly with the teeth on the compressor flywheel, which is of standard weight for machines of this capacity. The gears are protected by proper guards. The units run with remarkable freedom from vibration and noise.

Independent concrete foundations are used. Each unit has its own automatic oiling systems on all bearings, fed from a central tank. The drip is recovered and filtered. Sight-feed oilers care for cylinder lubrication. The illustration shows the arrangement of the air plant. The machines are side by side, the switchboard, rheostats, meters, etc., mounted in front of and between them. An intake duct, supplying both compressors, leads under the floor to the open air and rises beside the power-house, terminating in a screen cover for the exclusion of dust and cinders from the yards.

The discharge pipes from the two unite in an air main leading to the primary receiver outside the plant. Provision is made for draining this receiver. From this point, the line leads to a system of cooling tubes to the west of the power-house, made up of a large upper and lower horizontal header, connected by a number of small vertical pipes. This arrangement freely exposed to the air, precipitates whatever moisture may remain in the air after leaving the primary receiver; and this water is withdrawn from the lower header. From this cooler, air lines radiate throughout the yard, supplying power to the pneumatic switch and signal system controlling the movement of trains in the terminal track system. Secondary air receivers are also located at suitable places. The air is used almost entirely in this system of switches and signals. But a small portion is diverted to the boiler room, where it is applied in a small air-lift pumping outfit which supplies water to the terminal. The engineers in charge report an excellent performance of this equipment, which has been in severe and continuous service for several years.

The Cooper Hewitt Mercury Vapor Lamp and Interrupter in France.

At a recent meeting of the Société Internationale des Électriciens, M. Maurice Leblanc presented an interesting and valuable study of the Cooper Hewitt mercury vapor lamp and interrupter. M. Leblanc first described the phenomena observed when a current was passed through an exhausted tube containing mercury. He then described the different types of lamp, the difficulties met in operating them, the methods of starting, and gave curves for performance. The application of this device for rectifying alternating currents was also dealt with thoroughly, as well as the mercury vapor interrupter and the mercury vapor circuit-breaker.

Important Installations of Automatic Telephone Apparatus.

The Automatic Electric Company, Chicago, Ill., has recently closed three contracts of considerable interest to telephone men. The largest is for a 15,000-line automatic telephone system for Havana, Cuba. This is to displace the old "red telefonica" system of Havana, formerly owned by a Spanish company, but now a part of the properties of the Cuban Telephone and Telegraph Company.

The latter company at the same time contracted with the Automatic Electric Company for a 600-line automatic system for the town of Marianao, Cuba, a suburb of Havana. The initial installation at Havana will be 5,000 lines.

The Cuban Telephone and Telegraph Company will soon erect a new building and lay a new conduit and cable system for the new plant.

The officials of the Cuban Telephone and Telegraph Company who came to Chicago late in June to close the contract were: president, Roland R. Conklin; vice-president, S. L. Jarvis, and general manager, W. M. Talbott.

The other two contracts recently granted the Automatic Electric Company were for a 250-line exchange at Miamisburg, Ohio, for the Montgomery County Telephone Company, and a 1,200-line exchange for the Dakota Central Telephone Company at Aberdeen, S. Dak.

These two latter exchanges will be the first to have the new automatic four-party lines with selective ringing and lockout recently worked out by the Automatic Electric Company's engineers.

The Annual Conference of the Franklin Electric Manufacturing Company's Selling Organization.

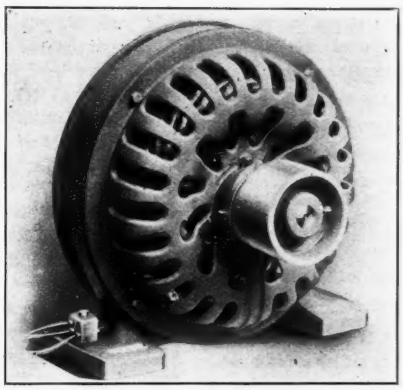
The annual conference of the selling organization of the Franklin Electric Manufacturing Company, Hartford, Ct., was held on June 27, 28, 29 and 30. The members in attendance were C. I. Hills, J. Camp, E. D. Redfield, J. W. Morrell, E. B. Hatch, J. A. Butler, P. S. Klees, H. O. Curtis, C. N. Thorpe, F. E. Wilson, C. Leonard, H. A. Truitt, T. G. Truitt, I. M. Johanson, J. D. Morrell and D. S. Morrell.

The programme included a smoker on Tuesday evening, June 27, a conference at the factory at 9.30 A. M., a baseball game at 2.30 P. M., and a dinner at the Hartford Canoe Club on the evening of June 28. On June 29 the party left Hartford at 8.55 A. M. for Deep River, and from 10.30 A. M. to 1 P. M. enjoyed a sailing and fishing trip. From 1 P. M. to 2 P. M. lunch was served, and from 2 P. M. to 5 P. M. athletic sports were indulged in. From 5 P. M. to 6 P. M. there was a shore dinner, and at 6.40 P. M. the party left for Hartford.

On Saturday, June 30, from 9.30 A. M. to 3.30 P. M. there was a conference at the factory; at 3.30 an automobile trip, and at 7 P. M. dinner at the Hartford Club.

New Type Polyphase Induction Motors.

A new type of polyphase induction motor has recently been placed on the market by the Westinghouse Electric and Manufacturing Company, which is designated as type CCL. These motors are manufactured in sizes from one-half to seventy-five horse-power and are wound for operation on two or three-phase circuits at voltages of 200 and 400 for all sizes except the one-half horse-power. The sizes from

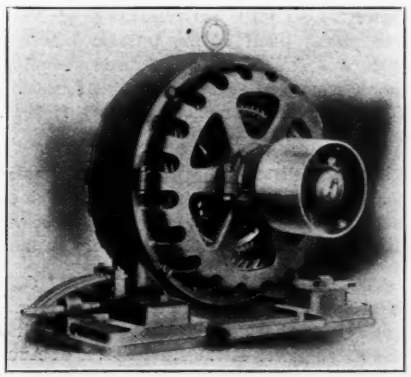


THREE-HORSE-POWER, THREE-PHASE, TYPE CCL MOTOR.

one-half to five horse-power inclusive are also wound for 100 volts.

The frame of the motor consists of a solid, cylindrical cast-iron yoke to the ends of which are bolted brackets which carry the bearings. These brackets are open so as to provide good ventilation, and may be fastened to the frame in any of four different positions, making the motor suitable for floor, wall or ceiling mounting. Motors up to and including the five horse-power have solid brackets and bearings, with slotted holes in the feet for adjusting the tension of the belt. Larger machines have the brackets and the bearings split horizontally, greatly facilitating the removal of the bearings, should this become necessary. Belt adjustment on these motors is made by tension screws which shift the motor on a cast-iron bedplate. There are no wearing parts on the machine except the bearings, and as these are of ample dimensions with a light rotor and flooded lubrications maintained at all times by means of oil rings, the wear is exceedingly slight.

The stationary part of the motor is the primary or element which is connected to the source of current. The magnetic circuit consists of circular laminations of sheet steel, securely keyed into the cast-iron frame. Terminal leads are brought

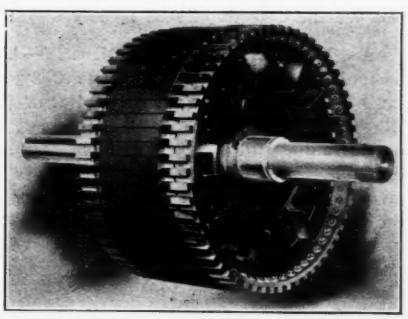


FIFTEEN-HORSE-POWER, THREE-PHASE, TYPE CCL MOTOR.

out at the base of the frame, being held in a cast-iron cleat. Hand-connectors or knuckle joints, such as are supplied with railway motors, are used to connect the motor to the supply circuit.

The secondaries of all CCL motors are of the squirrel-cage type, a construction which is extremely simple, rigid and durable, and which has given universal satisfaction. The winding consists of square copper bars lying in partially closed slots and bolted at the ends to metallic rings of ample cross-section to dissipate the heat generated in them. For the one-half horse-power motor round bars are used and are riveted to brass or copper rings at each end.

The design and principles governing the construction of these motors are particularly favorable to maintain good efficiencies at low loads, which ensure a high all-day efficiency, as in general service motors may operate at light loads much of the time. They are in every way repre-



ROTOR, TYPE CCL MOTOR.

sentative of the best methods in design and manufacture and are fully up to the high standards of the Westinghouse apparatus. The motors, following the precedent established by type C motors, are provided with liberal bearings and shafts, and adjustment of the bearings is unnecessary.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

THE ONTARIO POWER COMPANY'S PLANT STARTED UP—The power plant of the Ontario Power Company, Niagara Falls, Ont., was started up on Saturday evening, July 1. Work on this power plant was begun on March 19, 1902. The regular work of construction was commenced on May 1, 1903.

AMERICAN PNEUMATIC TOOL COMPANY PURCHASES GERMAN FIRM—The Chicago Pneumatic Tool Company has recently purchased the factory and business of C. G. Eckstein, of Berlin, Germany, which company will be utilized to produce material to meet the requirements of the Continental customers.

TO DEVELOP A POWER PLANT ON THE HURON RIVER—It is announced that the American Development Company, of New York city, is back of a project with a capital of $30,000,000 to develop the water power of the Huron river at Ann Arbor, Mich. One of the features involves the creation of a large reservoir lake near Geddes, Mich.

CHEAPER RATES TO KOREA—The Postal Telegraph-Cable Company announces that a reduction of twenty cents a word is made in the cable rate to Korea. This is effected through the Commercial Pacific cable *via* San Francisco and the Philippine Islands. The rate is reduced from $1.53 to $1.33 a word from Baltimore, Md., to Chemulpo, Fusan and Seoul. An additional charge of seventy-four cents a message is made for the delivery of messages on board vessels lying in the roadstead at Chemulpo.

SOUTH CAROLINA STREET RAILWAY COMPANY INCREASES CAPITAL—The capital of the Columbia (S. C.) Electric Street Railway Company has been increased from $500,000 to $1,600,000. This is following the plan for the merger of the Canal and Development Company and the street railway company. It is understood that there will be $600,000 worth of preferred stock, a part of which will be issued to take up the old stock of the street railway company; and $1,000,000 worth of common stock.

NEW MICHIGAN ROAD—An electric railway is being promoted between Janesville and Waupaca, Wis. The cost of the road will be $2,500,000. This line, if built, will tap an extensive tobacco country, as well as a sugar beet district. The principal towns to be touched would be Edgerton, Jefferson, New London, Waterloo, Dartford and Berlin. As the Milwaukee Electric Railway system is soon to be extended to Waupaca, there would be through electric road connections with Janesville from Milwaukee. This route is not at the present time duplicated by any steam road.

A NEW TELEPHONE COMPANY—A new telephone company composed of the Coast Telephone Company, organized under the laws of South Dakota, with a capital of $10,000,000; and the Coast Line Telephone Company of New Jersey, organized under the laws of that state with a capital of $1,000,000, has announced that it will begin business immediately, the former company to be the construction company, and the latter the operating company. It will do business, it is stated, in conjunction with other independent companies throughout the state of New Jersey, and will cooperate with the State Line Telephone Company and the Atlantic Telephone Company, both of New York city. Application will be made to the authorities of New Jersey for permission to erect poles and string wires. The president of the first-named company is Elias S. Beach, and S. M. Conger is treasurer, both of New York. D. A. Reynolds, of Brooklyn, N. Y., is president of the latter-named company, and manager of the Atlantic Telephone Company, of New York. E. D. Clark, of Jersey City, is secretary. The board of directors of both companies is as follows: E. A. Rogers, Eugene H. Brock, W. F. Midlige, John J. Toffey, E. V. Haggerty, T. B. Stolet, W. M. Reynolds, E. T. Burroughs, Daniel E. Cleary, George E. Hall, E. D. Clark, Gustav Lembeck, Stephen M. Conger, D. A. Reynolds and J. V. Throckmorton.

LEGAL NOTES.

TESLA SPLIT-PHASE MOTOR DECISION—In the United States Court of Appeals for the Third Circuit an opinion was filed in the Tesla split-phase motor suit involving patents Nos. 511,559 and 511,560, in the motion for a preliminary injunction, concurring in the conclusion reached by the lower court, overruling the plea of the appellant and granting a preliminary injunction. The Jefferson Electric Light, Heat and Power Company was the appellant, and the Westinghouse Electric and Manufacturing Company, the appellee.

THE RIGHT OF A TELEPHONE COMPANY TO DENY SERVICE—An interesting decision concerning the privilege of a telephone company to deny service to a party suspected of selling pools on horse races has been handed down by Judge Willard Bartlett in the Supreme Court, Appellate Division, Second Judicial Department of the City of New York. The case came up on appeal by James R. Cullen from an order of the Supreme Court entered in the office of the clerk of Kings County on March 16, denying an application for a peremptory writ of mandamus to compel the New York Telephone Company to render telephone service to the appellant. At the special term the judge denied the appellant's application for a peremptory writ. The papers presented to the court at the special term in this case set out facts and circumstances warranting a suspicion on the part of the police authorities that the premises formed a part which were used for pool-selling purposes prior to the beginning of the appellant's tenancy. The papers also alleged that the frequency of the appellant's presence justified the inference that he was cognizant of the fact that the law had been thus violated there. The New York Telephone Company had been informed by the police department that the premises had been used as a poolroom. It was also true that a telephone which it had previously installed therein had been removed therefrom by the police. The further language of the decision is as follows: "The officers of the company might not unreasonably apprehend that they would render themselves liable for aiding and abetting a violation of the law if they furnished further telephone service to the premises, in view of this information. It was quite proper, therefore, for them to request the assurance from the appellant which the contracting agent suggested, and for them also to require the appellant to furnish a reference as to his character. The action of the corporation in refusing to comply with the appellant's demand until the assurance and reference thus requested should be supplied was not a final refusal. This attitude on the part of the defendant corporation, if nothing else, justified the court at special term in denying the appellant's application for a discretionary and prerogative writ of mandamus. The order appealed from should be affirmed."

OBITUARY NOTICE.

MR. W. W. DONALDSON died at Elk Ridge, Md., on June 12. Mr. Donaldson was born on June 16, 1863, at Baltimore, Md., receiving his early education at a private school. At the age of eighteen he entered Princeton University. After studying at Princeton for a little over a year he took up special courses in chemistry and physics in Baltimore. In February, 1884, he took up storage battery work, and became connected with the Storage Battery Company, of Baltimore. He later was associated with the Eastern Electric Company and the Donaldson-McCree Storage Battery Company. He was president of this company for three years, being joint inventor with Mr. McCree of the battery manufactured by the company. He became engineer of the Automobile Manufacturing Company, of Baltimore, in 1899, and assumed the position of electrical engineer of the Gould Storage Battery Company, of New York city, in 1901. Mr. Donaldson occupied this position at the time of his death, although for some time past he had been on a protracted vacation seeking to recuperate his health.

PERSONAL MENTION.

MR. A. L. TETU, manager of the Home Telephone Company, of Nashville, Tenn., has been appointed a member of a select committee which will investigate the telephone situation in the Dominion of Canada. Mr. Tetu is now on his way to Ottawa.

MR. SAMUEL A. FRESHNEY, of Muskegon, Mich., general manager of the Muskegon Traction and Lighting Company, has been appointed commissioner of public works in Grand Rapids, Mich. The office is a new one, carrying with it a salary of $2,000.

MR. WILLIAM H. BLOOD, president of the National Electric Light Association, made a visit to New York last week to confer with several officers of the association upon policies to be pursued during the coming year. A number of committees will soon be appointed by Mr. Blood, and active work inaugurated looking to increasing the membership and value of the association.

MR. J. B. INGERSOLL, of Pittsburg, Pa., has joined the staff of the Spokane & Inland (Wash.) Electric Railway as electrical superintendent. He has recently completed his work on the electric line between Indianapolis, Ind., and Rushville, Ind. Eighteen months ago Mr. Ingersoll installed the first electrical plant for the Cœur d'Alene road. Until recently he was construction engineer for the Westinghouse Electric and Manufacturing Company.

MR. EDWARD R. KNOWLES, of New York, N. Y., has been retained as consulting engineer for the light, power and heat installations for the new factory to be erected in Jersey City, N. J., for M. Calm & Brother, and also for the new factory to be erected in Brooklyn, N. Y., for the S. S. McClure Publishing Company. Mr. Knowles is now making the light and power installations in the North River Insurance Company and the Gibson buildings, New York city, N. Y.

MR. H. N. KITTSON has accepted the presidency of the Central Ontario Power Company. Mr. Kittson is president of the Hamilton Board of Trade, being partner of Gillard & Company and a director of other prominent Hamilton (Ontario) companies. He only identified himself with the Central Ontario Power Company two months ago and then accepted a directorship, but since considerable Hamilton money is being invested in the company he accepted the presidency. Power will be transmitted from Burleigh falls to Peterboro, Oshawa, and other towns.

MR. WILLIAM F. DUNCAN, of Brooklyn, N. Y., has assumed the duties of general superintendent of the Trenton, N. J., systems of the New Jersey & Pennsylvania Traction Company. This work was formerly looked after by John G. Honecker, vice-president and general manager of the company. Mr. Duncan has control of all traffic arrangements of the lines radiating from Trenton. Mr. Honecker will continue his duties as vice-president and general manager. Mr. Duncan goes to Trenton from the system of the Brooklyn Rapid Transit Company, with which he was engaged as division superintendent. He was with the Brooklyn company twenty-five years and has an extensive practical experience in all branches of trolley roads. He was a trustee of the Employés Benefit Association of the Brooklyn Rapid Transit Company and previous to his appointment as division superintendent there held other offices of responsibility and trust.

ALLIS-CHALMERS PERSONNEL—Mr. A. H. Whiteside, who has for a considerable time been manager of the Allis-Chalmers Company's district office at Atlanta, Ga., was transferred on July 15 to the Philadelphia district office, where he succeeds as manager Mr. W. A. Wood, resigned. Mr. M. W. Thomas has been appointed manager of the Allis-Chalmers Company's district office at Atlanta, Ga. Mr. Thomas is widely known in the South, where he has been identified for years with electrical and machinery interests. He was until recently manager of the Westinghouse Electric and Manufacturing Company's office in New Orleans, and brings to the Allis-Chalmers Company the advantages of a very large and valuable acquaintance. Mr. W. J. Buckley, who has earned a widespread and enviable reputation as a successful salesman of power and electrical machinery in the Southwest, has been appointed manager of the Allis-Chalmers Company's district office at St. Louis. Mr. H. P. Hill, whom he succeeds, goes to the Salt Lake City district office, where he will devote himself to his specialty, the electrical features of the company's business. The Allis-Chalmers Company has never before had its electrical department's products directly represented in that district.

ELECTRICAL SECURITIES.

The record of the proceedings in the stock market during the past week was peculiar, in that there were so many reactionary turns both for good and bad. Early in the week there was a sharp break which brought prices tumbling, but with the extremely good bank statement, at the close the market, which for a couple of days had been stagnant, was turned into one of great activity. It is a disappointment, however, that the outside investing public did not respond with more alacrity to the influences which promoted a turn for the better. The government corn crop report is encouraging, and the cotton report is more hopeful than had been expected.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JULY 15.

New York:	*Closing.*
Brooklyn Rapid Transit	69⅝
Consolidated Gas	190
General Electric	175
Interborough Rapid Transit	201
Kings County Electric	200
Manhattan Elevated	165¼
Metropolitan Street Railway	126¼
New York & New Jersey Telephone	165
Westinghouse Manufacturing Company	190

At a special meeting of the stockholders of the Kings County Electric Light and Power Company the proposition to increase the capital stock from $5,000,000 to $10,000,000 was ratified.

The gross earnings of the New York City Railway Company for June, amounting to $1,887,834, include the earnings of the Metropolitan system, Third Avenue line and the Central Crosstown line. These figures compare with $1,865,065, the earnings of the same lines in the corresponding month of 1904.

The Brooklyn Rapid Transit Company, which is making improvements to its entire system, will, in addition to expenditures already announced, spend $250,000 in rearranging the Thirty-sixth street station and $250,000 in repainting all the elevated structures. One hundred new elevated cars are to be delivered early next month, furnishing capacity for 90,000 passengers.

Boston:	*Closing.*
American Telephone and Telegraph	139½
Edison Electric Illuminating	242½
Massachusetts Electric	62
New England Telephone	138
Western Telephone and Telegraph preferred	101

A special meeting of the stockholders of the Massachusetts Electric Companies is called to be held at twelve o'clock, Friday, July 28, in Gilbert Hall, Tremont Temple, to see if the shareholders "will consent that the trustees may pledge, mortgage and encumber certain shares in corporations now held and hereafter to be acquired by them for the purpose of refunding certain outstanding obligations of the Massachusetts Electric Companies, and for other purposes which may be approved by the shareholders and, if so, upon what terms." The passage of the above vote requires a two-thirds stock vote of each class of stock. The special meeting of Massachusetts Electric Companies' stockholders called for July 28 is for the purpose of taking care of the issue of $2,700,000 4½ per cent coupon notes which mature January 1, 1906. A new issue of these notes will be made of the same amount and rate.

Philadelphia:	*Closing.*
Electric Company of America	12
Electric Storage Battery common	82
Electric Storage Battery preferred	82
Philadelphia Electric	8 3/16
Philadelphia Rapid Transit	28
United Gas Improvement	94

The city councils of Philadelphia have passed ordinances repealing the trolley franchise grants previously passed over the mayor's veto, taking from the Philadelphia Rapid Transit Company nearly 100 miles of street rights.

Chicago:	*Closing.*
Chicago Telephone	130
Chicago Edison Light	160
Metropolitan Elevated preferred	65
National Carbon common	64
National Carbon preferred	115
Union Traction common	7
Union Traction preferred	37

The Chicago city council has granted the Metropolitan Elevated permission to carry freight and express. The grant is for ten years.

NEW INCORPORATIONS.

HARRISBURG, PA.—Merchants' Light and Power Company, Allentown. $50,000.

COLUMBUS, OHIO—Farmers' Telephone Company, Perrysville. Increased from $3,000 to $6,000.

BUFFALO, N. Y.—The Consumer Power Company, of Buffalo. To supply electricity for light and power. $200,000.

ALBANY, N. Y.—Plainville Telephone Company. $2,000. Incorporators: William B. Cox, Melta S. Wilson, Enos Smith, Plainville, and others.

FRANKFORT, KY.—Paducah Home Telephone Company, McCracken County; $250,000. Lynn Grove Independent Telephone Company, Calloway County, $2,000.

ALBANY, N. Y.—The Rock Raft, Cannonsville & Granton Telephone Company, Granton, Delaware County. $260. Directors: D. C. Gregory, F. R. Terry, J. B. Miller, Granton.

TOLEDO, OHIO—The Grand Rapids Mutual Telephone Company. $10,000. Incorporators: L. E. Carson, G. H. Clantz, E. A. Hall, John McLain, L. S. Abbott, A. W. Nafus and Herman Greaf.

GUTHRIE, OKLA.—The Fort Cobb Telephone Company, of Oklahoma City. $2,500. Incorporators: R. A. Wooldridge, of Oklahoma City; E. J. Luce, of Fort Cobb, and Jonathan H. Wright, of Oklahoma City.

RICHMOND, VA.—Brunswick Mutual Telephone Company, Lawrenceville, Va. $25,000. Incorporators: L. H. Raney, president; I. E. Spatig, vice-president; F. W. Davie, secretary-treasurer, all of Lawrenceville, Va.

GUTHRIE, OKLA.—Harrah Rural Telephone Company, of Harrah, Oklahoma County. $5,000. Incorporators: Karl Haas and Marion E. Platt, of Harrah; J. W. Stevens, R. M. Proffitt and W. O. Henderson, of McLoud.

HATTIESBURG, MISS.—Hattiesburg Traction, Light and Fuel Company. $250,000. Officers: H. A. Camp, of Lumberton, president; A. F. Thomasson, secretary and treasurer, and H. L. McKee, late of Meridian, general manager.

ALBANY, N. Y.—The Auburn & Ithaca Traction Company, Ithaca. To operate an electric street railway forty miles, from Auburn to Ithaca. $400,000. Directors: Sherman Collins, Ithaca; E. B. Mosher, I. P. Hazard, Poplar Ridge.

LITTLE ROCK, ARK.—The Little Rock & Hot Springs Electric Railway Company. To build an electric railway between Little Rock and Hot Springs, Ark., a distance of sixty miles. Officers: president, C. J. Kramer, of Little Rock; secretary, J. C. Marshall, of Little Rock; treasurer, George W. Rogers, of Little Rock.

INDIANAPOLIS, IND.—Winona Railway Company. $500,000. Directors: Thomas Kane, William M. Kamp, H. J. Heintz, E. F. Yarnelle, J. F. Beyer, L. F. Marshall, S. C. Dickey, J. M. Studebaker, William D. Frazer, M. Dukes, J. E. Beyrer, A. J. McDonald, A. P. Burchfield, F. T. Torrence, C. H. Worden and E. A. K. Hackett.

MOLINE, ILL.—Rock Island & Monmouth Railway Company. To construct a railroad from Rock Island, through the counties of Rock Island, Mercer and Warren, to Monmouth. $5,000. Incorporators and first board of directors: James E. McGrath, Chester E. Church, Thomas A. Church, Clarence S. Church and Louis G. Church, all of Chicago.

ALBANY, N. Y.—The Olive Telephone Company. To maintain and operate a line from Shokan to Kromville, within the town of Olive, a distance of twelve miles. $500. Directors: Frank Roosa, Jacob V. Merrihew and Granville Davis, of Olive Bridge; Joseph S. Hill and John G. Eckert, of West Hurley, and Elisha Merrihew and Hugh Donohue, of Kromville.

GUTHRIE, OKLA.—Muskogee & Texas Railway Company. To run from Cushing, Okla., to Honey Grove, Tex., 250 miles, starting from Cushing, running through Payne County east, and through the Creek Nation to Muskogee, thence through the Creek and Cherokee Nations to Porum, I. T., thence through the Cherokee and Choctaw Nations and Texas to Honey Grove. $460,000. Incorporators: Horace Speed and Thomas J. Lowe, of Guthrie; Walter Eaton, Henry G. Baker and Norman R. Haskell, of Muskogee.

ELECTRIC LIGHTING.

CALHOUN, GA.—George C. Chambers has applied to the Calhoun council for an electric light franchise.

PORTLAND, ME.—The Consolidated Electric Light Company has started the work of putting its wires underground.

BUCYRUS, OHIO—The Crawford Gas and Electric Company, of Galion, has prepared plans for the erection of a $15,000 power-house.

PORTLAND, MICH.—The municipal lighting plant will be closed during August for repairs and improvements. The work will cost about $3,760.

NEWTON, IOWA—The Newton city council has decided to purchase an $8,000 storage battery equipment for the electric light plant in order that day service may be had.

INDIANAPOLIS, IND.—The city council has passed the ordinance ratifying the new franchise for the People's Light and Heat Company, which will succeed the Home Heating and Lighting Company.

LIMA, OHIO—The board of public service has awarded the contract to furnish power for the new waterworks reservoir to the Lima Electric Railway and Light Company, at its offer of five cents per kilowatt-hour.

NORTH TONAWANDA, N. Y.—The board of aldermen has entered into a contract with the Tonawanda Power Company to furnish the city of North Tonawanda with 198 arc lamps at $70 per lamp for two years.

WICHITA, KAN.—At a special meeting of the Wichita city council the contract for the city arc lights was awarded to the Wichita Railroad and Light Company, which agrees to furnish 217 lights every night until one o'clock at $14,543.50. The contract is for five years and will be dated July 1, 1905.

BRISTOL, VT.—The Lake Dunmore Power and Traction Company is rushing work on its new power-house at Rocky Dale. The new house will be thirty by fifty feet, 740 feet from the present one and forty feet lower. The stone foundation walls will reach five feet above the floor level. The floor will be of concrete.

BUFFALO, N. Y.—A private right of way ten feet wide from Niagara Falls to Buffalo has been secured by the Lackawanna Steel Company, for the purpose of building a transmission line over which it expects to receive 15,000 horse-power daily. It has been decided to use electricity as far as possible in the operation of the plant.

OMAHA, NEB.—Contracts for the electric lighting plant to be installed at Fort Crook have been let. The Gerggren Electrical Company, of St. Paul, gets the $21,278 contract for installing the machinery. Another contract for $3,260 is awarded the General Electric Company. The contract to supply the current has been awarded the Omaha Electric Light and Power Company.

GREENVILLE, S. C.—At a meeting of the city council a charter was granted the Saluda River Power Company to sell electric power in Greenville for a period of forty years. A. Lester Furman is president of the power concern, and it is controlled by Greenville men. It has a capital of $300,000, and is now constructing a dam on Saluda river, from which power is to be brought to the city.

ANN ARBOR, MICH.—The Washtenaw Light and Power Company announces a reduction of practically twenty per cent in the cost of residence lighting. The new rates are twelve and one-half cents per kilowatt-hour, with an extra reduction of ten per cent if the bill is paid by the fifteenth of the month, making the cost eleven and one-quarter cents in the future, as against the former rate of thirteen and one-third cents.

ROCK HILL, S. C.—Arrangements for the installation of electric power at the Highland Park Mill, superseding steam, which has furnished the power for the plant since its erection, have been completed. In the carding and spinning room there will be two seventy-five-horse-power motors, one thirty and one forty-horse-power motors. For the weaving department there will be one 150-horse-power motor and one seventy-five-horse-power motor.

NEWBURGH, N. Y.—The negotiations of the Newburgh Electric Light, Heat and Power Company, for the purchase of the plant of the Cornwall Electric Light and Power Company, have been carried to a successful termination. As soon as the arrangements can be made the plant at Cornwall will be closed and the current for lighting that village and supplying power to business places will be supplied from Newburgh. The service will be continuous.

TELEPHONE AND TELEGRAPH.

DENISON, TEX.—The town council has granted a franchise to the Grayson County Telephone Company to do business in Pottsboro.

OSWEGO, N. Y.—The Ontario Telephone Company will shortly begin work on its new exchange. The plans call for a two-story building of the most modern type.

WAPAKONETA, OHIO—The Auglaize Telephone Company, of Waynesfield, Ohio, has increased its capital stock from $15,000 to $20,000. This company operates nearly 400 telephones at Waynesfield, and most of its subscribers are farmers.

HAMILTON, OHIO—The Hamilton Bell Telephone Company will erect in Hamilton a modern, up-to-date exchange building, with accommodations for 6,000 subscribers. The building will cost $50,000. The company will install a switchboard which will cost $30,000.

TOLEDO, OHIO—The Rising Bell Telephone Company, of Risingsun, Wood County, capital $25,000, has been incorporated by T. F. Sylvan, J. P. Daniels, W. R. Nutt, H. J. Bowen, T. A. Reed. The company will install a small plant in Risingsun and give its business to the Bell.

ALFRED, N. Y.—The Bolivar Telephone Company has bought the telephone system of the Oswayo Valley Telephone Company, with headquarters at Shingle House, Pa. The Bolivar company has added fifty subscribers to its Bolivar system and thirty to its Allentown system recently.

PADUCAH, KY.—The People's Independent Telephone Company passes into the hands of the Paducah Home Telephone Company, a newly organized company. The incorporators of the new company are J. C. Monteith, of Bloomington, Ind.; J. E. Bergin, of Nanticoke, Pa., and J. Wheeler Campbell, of Paducah. The capital stock is fixed at $250,000.

UTICA, N. Y.—The Central New York Telephone Company has begun the construction of a rural telephone exchange system, which, when completed, will embrace the villages of Trenton, Remsen, Trenton Falls, Gravesville, South Trenton, Holland Patent, Stittville, Steuben and the Steuben valley, together with all intermediate resident farmers.

WINCHESTER, VA.—Judge Thomas W. Harrison has decided an important case in the circuit court, growing out of an injunction restraining the United Telephone Company from erecting a telephone line on the Winchester and Martinsburg turnpike. The court decided that as the company was a foreign corporation not paying taxes as required by the state, and not having a charter from the state corporation commission, it had no legal standing and no right to conduct a telephone business.

NEW HAVEN, CT.—The Southern New England Telephone Company has ordered a census to be made of all the houses in the state of Connecticut with a view of offering telephone facilities and making new extensions. The common battery system is soon to be extended to the secondary exchanges, which include New London, Norwalk, South Norwalk, Meriden, New Britain, Danbury, Norwich, Stamford and Middletown. The financial plans of the company contemplate the issue of $500,000 additional stock, making the total capital stock $5,000,000.

CLEVELAND, OHIO—Holders of preferred stock in the Cuyahoga Telephone Company received $59,674.50 in dividends July 6. The earnings have been growing recently at a cumulative rate, which enabled the directors to announce the declaration of the first dividend. Of the authorized 30,000 shares of the preferred stock, 13,961 had been issued, the remainder being held as treasury stock in the control of the Federal Telephone Company, the holding company. The dividend on the reserve stock will amount to $75,325.50, the total being $135,000.

TOLEDO, OHIO—The Citizens' Telephone Company, of Waterville, which was recently incorporated, held a meeting to perfect organization, and elected the following officers: president, C. E. Shaffmaster; vice-president, H. F. Van Fleet; secretary and manager, D. J. Farnsworth; treasurer, C. R. Shoemaker. The officers, with Dr. J. R. McOscar, will constitute the board of directors. The capital stock of the company is $50,000, and most of the stock has been taken by Waterville citizens. The plant, which has about 200 telephones, was built by D. J. Farnsworth.

ELECTRIC RAILWAYS.

GOSHEN, IND.—A fifty-year franchise has been granted the Huntington, Columbus City & Goshen Interurban Railway.

SNOHOMISH, WASH.—All interest in the Snohomish & Cherry Valley trolley line has passed from the control of the original promoters into that of a new company to be organized among local capitalists. The most active backers of the proposed company are Mayor C. S. La Forge, of Snohomish; J. B. Brown, Victor Marshall and Milton Stephens.

CUMBERLAND, MD.—The Elk River Railway and Electric Power Company, of Sutton, W. Va., has been incorporated to build an electric railway about five miles long from Gassaway, W. Va., to Sutton, W. Va. The incorporators are George H. Borlean, of Pittsburg; W. H. Cochran, of Dawson, Pa.; J. T. Berry, of Hesters, W. Va.; L. W. Martin, and John B. Morrison, of Sutton, W. Va.

WEST CHESTER, PA.—A contract has been awarded by the Philadelphia & Western Railroad for its entire electrical equipment to the General Electric Company, involving an expenditure of over $1,000,000. The contract involves the complete equipment of both a temporary and a permanent power-house and all of the passenger cars now under construction by the St. Louis Car Company.

OMAHA, NEB.—A syndicate of eastern capitalists has agreed to finance and back the construction of the Sioux City, Homer & Southern Railroad from Sioux City to Omaha. Already sixteen miles of the road have been graded and six and one-half miles of track have been laid. It is stated that as soon as the rest of the right of way has been acquired grading and laying of track for the remainder of the distance will be begun and prosecuted vigorously.

MECHANICSBURG, PA.—The Dillsburg and Mechanicsburg branch of the Cumberland Valley Railroad will, in the near future, be operated by electricity, and instead of the two trains a day, as at present, there will soon be hourly communication between Harrisburg and Dillsburg, made possible by connections with Valley traction cars at Trindle Springs. The stretch of railroad which will be operated by electricity branches off from the main line of the Cumberland Valley about one mile beyond Mechanicsburg, and runs to Dillsburg, a distance of a little more than seven and three-fourths miles.

OBERLIN, OHIO—At the first meeting of the stockholders of the Oberlin & Lorain Railway Company the directors elected were: William A. Donaldson and C. F. Herrick, of Lorain; W. F. Stanley, of Conneaut, and M. D. Skeels and C. R. Summers, of Oberlin. The board of directors chose the following officers: president, M. D. Skeels; vice-president, W. F. Stanley; secretary, C. R. Summers; treasurer, W. A. Donaldson. The company purposes to build an electric road between Oberlin and Lorain, running by way of North and South Amherst. Most of the right of way has been secured, and it expects to start grading in a short time.

DANBURY, CT.—The interstate trolley line which the Danbury & Harlem Traction Company is building from Danbury to Goldens Bridge, N. Y., a distance of about seventeen miles, has been practically completed from Danbury to the New York state line. The construction of the line westward will now be pushed. It is expected that the line will be completed to North Salem, N. Y., by August 1 and to Goldens Bridge by October 1. It is not probable that Goldens Bridge will be the western terminus of the road, as engineers are now developing plans for an extension from that town to White Plains, from which point trolley connections will be made to New York.

WILLIMANTIC, CT.—The house of representatives has passed in concurrence a resolution incorporating the Willimantic & Stafford Springs Street Railway Company. The company has a capital stock of $700,000, and it is authorized to construct and operate a trolley line in the towns of Windham, Mansfield, Willington and Stafford. The corporation is empowered to acquire and utilize abandoned or undeveloped water powers in Tolland County under certain restrictions. The incorporators are Costello Lippitt, Edwin W. Higgins and Lewellyn J. Storrs, of Norwich, and Charles W. Comstock, of Montville. The same men control a charter for a street railway from Norwich to Westerly, R. I.

INDUSTRIAL ITEMS.

THE TEA TRAY COMPANY, Mulberry and Murray streets, Newark, N. J., will be pleased to send its catalogue No. 13, descriptive and illustrative of incandescent street fixtures, hoods, shades and reflectors.

THE C. J. TOERRING COMPANY, Philadelphia, Pa., in bulletin No. 6, gives a most interesting talk on arc lamps. This bulletin describes the company's enclosed arc lamps for constant-potential 110-volt and 220-volt circuits.

THE NEW ENGLAND BUTT COMPANY, Providence, R. I., is distributing its catalogue in loose-leaf form. These leaves illustrate the braiding and cabling machines and special machinery for electrical wire manufactured by the company.

THE AMERICAN CONDUIT COMPANY, Chicago, Ill., is distributing a handsome bulletin describing bituminized fibre conduit. This bulletin is handsomely printed, and contains a considerable amount of interesting and instructive material.

THE CHANDLER & TAYLOR COMPANY, Indianapolis, Ind., has been the successful bidder for the 150-horse-power, high-speed, self-oiling direct-connected engine which is to be placed in the new power plant of Messrs. Mandel Brothers, Chicago, Ill.

G. M. GEST, New York and Cincinnati, the expert subway contractor, has a large force of men actively at work in Meridian, Miss., installing a conduit system for the Cumberland Telephone and Telegraph Company. This contract was awarded a short time ago.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is sending out data descriptive of the Sangamo direct-current wattmeter, for which it is distributing agent. The company reports that extensive additions to the factory are keeping pace with the growing demand for this wattmeter.

THE YOST ELECTRIC MANUFACTURING COMPANY, Toledo, Ohio, has issued a handsome booklet descriptive of the Yost specialties. This booklet gives a number of views of the company's product, showing the details of assembly. A price list is added to the catalogue, giving the most recent quotations on the apparatus illustrated.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has printed a special publication, No. 4000, descriptive of gold milling in the Black Hills. This is a reprint of a paper read before the American Institute of Mining Engineers by Professor H. O. Hoffman. Dakota School of Mines, Rapid City, S. D. Any one interested in this department of engineering will do well to secure this valuable treatise.

THE STANDARD WELDING COMPANY, Cleveland, Ohio, is distributing a hanger containing a table of decimal equivalents ranging from one-sixty-fourth to sixty-three-sixty-fourths of an inch. The progression is by sixty-fourths of an inch. The Standard Welding Company is now in a position to weld almost any form of material, from lamp brackets and metal frames to crank shafts and cylinders.

THE F. BISSELL COMPANY, 226-230 Huron street, Toledo, Ohio, distributed a very tasteful and popular souvenir in the shape of a scarf pin at the recent telephone convention at Chicago. A good many friends of the company were not in attendance at the convention, and the company wishes to send pins to all who have not received them. They will be mailed on request without charge. These pins are well worth writing for.

THE J. L. SCHUREMAN COMPANY, 70-86 West Jackson Boulevard, Chicago, Ill., will be pleased to send its large catalogue descriptive and illustrative of automatic motor-controlling devices. This catalogue is in perpetual form, and leaves are distributed from time to time to keep the material up to date. The apparatus manufactured by this company possesses a number of important features which specialize it for the work intended.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports having closed a contract with the North State Telephone Company, of High Point, N. C., for a 1,200-line capacity, generator call, visual signal switchboard. The company is under the management of Mr. J. F. Hayden, and is one of the most progressive telephone companies in the state. The Stromberg company has also closed a contract with the Anderson Telephone Company, Anderson, S. C., for a 1,800-line capacity, lamp line signal, multiple switchboard. Mr. E. S. Moorer, the general manager of the Anderson company, is making this independent plant one of the most modern in the South.

THE RELIANCE INSTRUMENT COMPANY, 60-68 Van Buren street, Chicago, Ill., will be pleased to send its new price list and descriptive matter concerning the Reliance voltmeters and ammeters. These meters are neat in design. The scale is long and hand-drawn; the moving parts work on hardened-steel pivots in jewel bearings, and the instruments have no permanent magnets, and can be made for alternating current or direct current.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has received an order for two size 898 Crocker-Wheeler engine-type, direct-current generators with a capacity of 10,000 amperes and 105 volts. These will be special machines with twenty-two poles, and will be used for electrolytic treating of ores. The speed will be 100 revolutions per minute. The machines will be installed at Carteret, N. J., in a plant where there are at present four Crocker-Wheeler generators of varying capacity up to 750 kilowatts.

THE MASON GAS POWER COMPANY, LIMITED, Levenshulme, Manchester, England, is distributing a handsome catalogue descriptive of its producer gas apparatus. This company manufactures apparatus for making producer gas for furnace work, producer gas for gas engines, the Duff patent gas producer, the Whitfield patent gas producer, the Weirdale patent gas-fired furnace; and the company is also the constructor of all types of furnaces. The catalogue contains many illustrations, and the descriptive matter is supplemented by physical data of much importance.

THE WYCKOFF PIPE AND CREOSOTING COMPANY, INCORPORATED, Stamford, Ct., is furnishing the Bell Telephone Company, of Philadelphia, Pa., with millions of feet of Wyckoff creosoted wooden conduits in connection with the construction work of the Delaware & Atlantic Telephone and Telegraph Company on its underground trunk line system in and around Philadelphia, Wilmington, Princeton, Trenton and Atlantic City. This conduit and the creosoted plank used to protect it are being furnished from the Portsmouth (Va.) factory of the Wyckoff Pipe and Creosoting Company. The Bell Telephone Company has recently placed an additional order with the Wyckoff company for about ninety miles of creosoted conduit and the necessary plank to lay with it.

THE BENJAMIN ELECTRIC MANUFACTURING COMPANY, Chicago, New York and San Francisco, has enjoyed a most remarkable growth during the past four years. The demand for the company's well-known line of wireless clusters and electrical specialties has made it necessary to double the floor space of its factory twice during the past twelve months. The company's plant at 42 West Jackson Boulevard, Chicago, is equipped with the most modern machinery, and a large corps of experts is working overtime to meet the constantly growing demand for the company's product. The Benjamin company has a large list of patents, and this line continues to grow. The company is now completing several new specialties, which will be listed in its new catalogue to be issued very soon.

HARVEY FISK & SONS, New York city, announce for sale 5,000 shares of the preferred stock of the Electric Bond and Share Company, at 92½. This company is incorporated under the laws of the state of New York with a capital of $2,000,000 preferred (entitled to cumulative preferred dividends at the rate of five per cent) and common stock of like amount. The officers of the company are: president, Marsden J. Perry, Providence, R. I.; vice-president and treasurer, Sidney Z. Mitchell, New York city; secretary and assistant treasurer, H. M. Francis, Schenectady, N. Y.; assistant secretary, J. D. Mortimer, New York city. The directors are: Marsden J. Perry, Philip L. Saltonstall, Jacob K. Newman, Charles A. Coffin, Charles W. Wetmore, Alden M. Young, Sidney Z. Mitchell, S. Reading Bertron, William M. Barnum, Robert Treat Paine, 2d, Homer H. Johnson, Lewis L. Stanton, William B. McKinley, Hinsdill Parsons, William H. Alms, Dwight W. Morrow and Graham Sumner. The Electric Bond and Share Company is a corporation organized under the laws of the state of New York, with power to purchase bonds, stock or other forms of securities resulting from electrical developments, such as electric street railways and electric light and power plants. It begins business with capital fully paid up and with a surplus estimated by its officers, after careful appraisal by a special committee appointed for the purpose, to be of the value of $440,000. All of the common stock is owned by the General Electric Company.